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This study investigates the Joint Vision 2010 concept of precision engagement and its impact on future AC-130 gunship modernization requirements. The primary purpose of this thesis is to assist long-range planners at United States Special Operations Command and Air Force Special Operations Command in the preparation of AC-130 modernization strategies which implement advanced technology precision engagement systems on the gunship.

This study employs a strategy-to-task-to-need approach to derive tactical-level precision engagement mission tasks from Joint Chiefs of Staff, conventional military service, and Special Operations Forces publications which describe the employment of precision engagement systems in support of twenty-first century military operations. Based upon these tactical-level precision engagement tasks, current Department of Defense science and technology planning documents are subsequently examined for advanced material technologies related to these mission requirements.

Ultimately, this thesis identifes specific material technologies and capabilities which should be installed on AC-130 gunships in order for this aircraft to provide effective firepower in support of military operations in the 2010 timeframe. The effort concludes with recommendations related to the implementation of these precision engagement capabilities on AC-130 gunships.

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PRECISION ENGAGEMENT: SHARPENING THE TIP OF THE SPEAR

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

PRECISION ENGAGEMENT: SHARPENING THE TIP OF THE SPEAR
by Major Brian K. Dougherty, USAF, 90 pages.

This study investigates the *Joint Vision 2010* concept of "precision engagement" and its impact on future AC-130 gunship modernization requirements. The primary purpose of this thesis is to assist long-range planners at United States Special Operations Command and Air Force Special Operations Command in the preparation of AC-130 modernization strategies which implement advanced technology precision engagement systems on the gunship.

This study employs a strategy-to-task-to-need approach to derive tactical-level precision engagement mission tasks from Joint Chiefs of Staff, conventional military service, and Special Operations Forces publications which describe the employment of precision engagement systems in support of twenty-first century military operations. Based upon these tactical-level precision engagement tasks, current Department of Defense science and technology planning documents are subsequently examined for advanced material technologies related to these mission requirements.

Ultimately, this thesis identifies specific material technologies and capabilities which should be installed on AC-130 gunships in order for this aircraft to provide effective precision firepower in support of military operations in the 2010 timeframe. The effort concludes with recommendations related to the implementation of these precision engagement capabilities on AC-130 gunships.

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Finally, I must acknowledge Nikki, for being man's best friend throughout the year and occasionally reminding me when it was time to eat and time to go play.

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LIST OF ABBREVIATIONS

ACTD	Advanced Concept Technology Demonstration
AFDC	Air Force Doctrine Center
AFDD	Air Force Doctrine Document
AFSOC	Air Force Special Operations Command
AFSOF	Air Force Special Operations Forces
AFSOF 2025	*Air Force Special Operations Forces 2025*
AFTL	*Air Force Task List*
AO	Area of Operations
ARSOF 2010	*Army Special Operations Forces 2010*
ASD/SOLIC	Assistant Secretary of Defense/Special Operations and Low Intensity Conflict
ATD	Advanced Technology Development
ATR	Automatic Target Recognition
BDA	Battle Damage Assessment
CAS	Close Air Support
CFJO	*Concept for Future Joint Operations*
CID	Combat Identification
CJCS	Chairman of the Joint Chiefs of Staff
CJCSM	Chairman of the Joint Chiefs of Staff Manual
CNO	Chief of Naval Operations
DEW	Directed Energy Weapons

DOD	Department of Defense
DPICM	Dual Purpose Improved Conventional Munition
DTAP	*Defense Technology Area Plan*
DTO	Defense Technology Objective
EO	Electro-Optical
GPS	Global Positioning System
HSOK	Hunter/Standoff Killer
JCS	Joint Chiefs of Staff
JEL	*Joint Electronic Library*
JFC	Joint Force Commander
JV 2010	*Joint Vision 2010*
JWCO	Joint Warfighting Capability Objective
JWSTP	*Joint Warfighting Science and Technology Plan*
MAJCOM	Major Air Command
MAP	Mission Area Plan
MCCDC	Marine Corps Concept Development Command
METL	Mission Essential Task List
MNS	Mission Need Statement
MOOTW	Military Operations Other Than War
MOUT	Military Operations in Urban Terrain
MPP	Modernization Planning Process
MTW	Major Theater War

NEO	Noncombatant Evacuation Operation
NMS	*National Military Strategy*
OCA	Offensive Counterair
OMFTS	*Operational Maneuver From The Sea*
ORD	Operational Requirements Document
PPBS	Planning, Programming, and Budgeting System
PSYOP	Psychological Operations
QDR	*Quadrennial Defense Review*
RCS	Radar Cross-Section
RDT&E	Research, Development, Test, and Evaluation
SEAD	Suppression of Enemy Air Defenses
SE&BE	Sensors, Electronics, and Battlespace Environment
SECDEF	Secretary of Defense
SOF	Special Operations Forces
SOF 2020	*Special Operations Forces Vision 2020*
S&T	Science and Technology
UAV	Unmanned Aerial Vehicle
UJTL	*Universal Joint Task List*
USAF	United States Air Force
USASOC	United States Army Special Operations Command
USSOCOM	United States Special Operations Command

CHAPTER 1

INTRODUCTION

For those who have flown on the AC-130 *Spectre* gunship or seen it perform in combat, just hearing the name *Spectre* evokes a mental image of precision firepower. For the past thirty years, AC-130 gunships have been widely regarded as one of the most precise air-to-ground attack platforms in the Department of Defense (DOD). Originally developed during the late 1960s, AC-130 gunships proved to be extremely effective during military operations in Southeast Asia. AC-130 gunships were also employed with great success during operations URGENT FURY in Grenada, JUST CAUSE in Panama, and DESERT STORM in Iraq and Kuwait. Most recently, these aerial gunships provided precision firepower in support of American and multinational ground forces operating in Somalia and Bosnia.

Today, the Air Force Special Operations Command (AFSOC) fleet of twenty-one AC-130 gunships forms the backbone of precision fire support assets assigned to United States Special Operations Command (USSOCOM), the unified combatant command which oversees all special operations forces (SOF) in the DOD. Though these formidable aircraft and the crews who fly them boast a distinguished combat history, a significant challenge presents itself to long-range planners at AFSOC and USSOCOM—what should be done to prepare the AC-130 gunship for military operations in the twenty-first century? This study attempts to answer this question by examining the material systems and capabilities AC-130 gunships will need in order to conduct precision fire support operations in the 2010 timeframe.

Background

In July 1996, former Chairman of the Joint Chiefs of Staff (CJCS) General John M. Shalikashvili published *Joint Vision 2010* (*JV 2010*). Still highly relevant today, this document provides an overarching vision of how American armed forces will conduct warfare in the 2010 timeframe. *JV 2010* describes how U.S. military forces will dominate future adversaries across the full range of military conflict via new warfighting concepts which will characterize military operations in the next century. By establishing a conceptual framework for these new levels of combat capability, *JV 2010* provides top-level direction to the military departments, the unified combatant commands, and other DOD agencies as they develop the military forces and equipment needed to meet warfighting challenges in the next century.[1]

JV 2010 focuses on the premise that modern and emerging technologies, particularly in the field of information collection and dissemination, will provide significant improvement in future warfighting capabilities. It describes four new warfighting concepts which will act as cornerstones for future military operations: dominant maneuver, precision engagement, full-dimensional protection, and focused logistics. *JV 2010* describes how the marriage of technological innovation with these four new concepts will enable U.S. military forces to dominate and defeat adversaries encountered during future military conflicts.[2]

JV 2010 identifies six critical elements required to transform these four new warfighting concepts into future military capabilities: people, leadership, doctrine, education and training, organizational structure, and material.[3] This study examines the

latter element, material, and its relationship to *JV 2010* operational concept of precision engagement. The goal of this thesis is to identify material systems and capabilities which will enable AC-130 gunships to fulfill the precision engagement requirements indicated in *JV 2010.*

Research Problem

Joint Vision 2010 is just that—a vision. Though it provides a strong conceptual foundation for the conduct of future military operations, *JV 2010* stops short of providing detailed, specific information regarding how the military services are to achieve its warfighting goals. Among its many premises, *JV 2010* suggests that advanced material systems and equipment must be developed in order to conduct warfare in the 2010 timeframe. *JV 2010* concludes by challenging the services, the unified combatant commands, and the defense acquisition industry to further explore its new operational warfighting concepts and enabling technologies, and to develop, acquire, and field advanced material systems which enable new levels of combat capability. This research effort responds to this challenge by exploring the precision engagement concept as it applies to AC-130 gunships, and by assessing the material technologies which will enable gunships to conduct precision engagement operations in the next century.

Since its publication, *JV 2010* has spawned a number of efforts within the DOD to further understand and expand its inherent requirements. In May 1997, the Joint Warfighting Center at Fort Monroe, Virginia published its *Concept for Future Joint Operations* (*CFJO*). This document further articulates *JV 2010*'s new warfighting concepts and provides a more detailed foundation for follow-on assessments of the

material requirements needed to respond to twenty-first century military challenges.[4] Additionally, the four military services and USSOCOM recently published twenty-first century vision statements which describe the warfighting roles, missions, and operations they intend to undertake in the next century. Though the *CFJO* and these new service visions embrace *JV 2010* in general and the concept of precision engagement in particular, they do not indicate specific mission tasks or material requirements related to AC-130 gunships. This research effort takes a logical step forward in the *JV 2010* implementation process by identifying specific material requirements necessary for AC-130 gunships to conduct precision engagement operations in the 2010 timeframe.

Study Significance

AC-130 gunships are currently programmed to remain in the DOD inventory through the year 2025. Though designated as SOF assets, AC-130 gunships are frequently tasked to support both conventional and special operations forces in all manner of military operations around the globe. As future warfare is expected to evolve per *JV 2010*, so must the AC-130 continue to evolve in order to remain a viable fire support asset for USSOCOM and the DOD. The first step in this evolution is to determine the precision engagement material needs applicable to AC-130 gunships.

In this thesis, specific AC-130 gunship mission tasks are derived from *JV 2010*, the *CFJO*, and service and SOF publications which paint the picture of twenty-first century warfare. Subsequent to this effort, the analysis presents material technologies related to these precision engagement mission tasks and applicable for implementation on AC-130 gunships. The intent of this thesis is to provide a foundation for future AFSOC

modernization strategies which focus on implementing advanced precision engagement technologies on AC-130 gunships.

Research Topic and Approach

This research study focuses on four primary efforts: understanding the *JV 2010* concept of precision engagement, assessing the future fire support requirements posed by current Army, Navy, Marine Corps, Air Force, and SOF vision statements, identifying the mission requirements and military tasks embedded in the precision engagement concept, and determining the material systems and capabilities AC-130 gunships will need in order to conduct precision engagement operations in the 2010 timeframe.

Primary Research Question

This study investigates and answers the following primary research question: What kinds of material systems and capabilities should be installed on AC-130 gunships in order for this aircraft to provide effective, precision fire support in the 2010 timeframe?

Subordinate Research Areas and Questions

In order to answer the primary research question, several subordinate research areas must be investigated. The first requirement is to examine *JV 2010* and the precision engagement concept in greater detail. The research effort begins with an assessment of the role *JV 2010* plays in national security strategy. Next, the study investigates how conventional military services and SOF envision the employment of precision engagement systems during future military operations. Analyses in this area attempt to shape future AC-130 mission tasks and material system requirements. Several research questions related to this topic are investigated:

1. How do the military services and SOF define the concept of precision engagement in light of their future roles and missions?

2. How do they intend to employ precision firepower in support of their operations in the 2010 timeframe?

3. What are the relevant similarities between service and SOF views on future precision engagement operations?

4. How does the precision engagement concept shape future AC-130 mission tasks and material system requirements?

The next subordinate research area focuses on determining specific precision engagement-related mission tasks applicable to AC-130 gunship operations. Two key research questions are examined here:

1. What are the explicit and implicit tactical-level tasks embedded in the precision engagement concept?

2. How will future military operating environments and battlefield conditions influence the accomplishment of these tasks?

The final subordinate research area investigates advanced material technologies and systems related to precision engagement operations and applicable for implementation on AC-130 gunships. The analysis in this area answers these questions:

1. What kinds of advanced material technologies are related to the tactical-level mission tasks embedded in the precision engagement concept?

2. Based upon the mission tasks and material technologies inherent to precision engagement operations, what kinds of material systems and capabilities should the AC-130 gunship have in order to conduct precision engagement operations in the 2010 timeframe?

Key Definitions

The following paragraphs define and describe key terminology related to this thesis. Key terms are underlined for clarity.

Air Force Special Operations Command. Air Force Special Operations Command oversees all special operations assets within the USAF, including AC-130 gunships. As the Air Force component of USSOCOM, AFSOC provides long-range mobility and fire support for SOF conducting special operations missions. AFSOC is also a major air command (MAJCOM) under the Department of the Air Force, and as such is responsible for developing and supporting Air Force-common material systems and equipment installed on AC-130 gunships.

Close Air Support. As indicated in *JV 2010* and the *CFJO*, close air support (CAS) provided by aircraft such as the AC-130 will continue to be a key element of future warfare. This "action by fixed- and rotary-wing aircraft against hostile targets which are in close proximity to friendly forces and which requires detailed integration of each mission with the fire and movement of those forces"[5] has been the centerpiece of the AC-130's distinguished combat history, and will be a primary influence in the development of future gunship precision engagement requirements.

Conventional Forces. The majority of U.S. military operations are conducted by conventional forces, which are defined in Joint Publication 1-02, *DOD Dictionary*, as "those forces capable of conducting operations using nonnuclear weapons."[6]

Dominant Maneuver. The *CFJO* defines dominant maneuver as "the multidimensional application of information, engagement, and mobility capabilities to position and employ widely dispersed joint air, sea, land, and space forces to accomplish the assigned operational tasks."[7]

Full Spectrum Dominance. The *CFJO* describes full spectrum dominance as the ability to dominate any adversary and control any situation in any operation across the range of military conflict.[8]

Joint Forces. Joint forces are "composed of significant elements, assigned or attached, of two or more Military Departments, operating under a single joint force commander."[9] Though they can operate independently, SOF are often employed in conjunction with conventional and joint forces.

Military Operations Other Than War. Though current American military strategy requires the U.S. armed forces to be ready to wage nearly simultaneous high-intensity warfare in two different regions around the globe, lower intensity military operations other than war (MOOTW) have dominated the use of American military forces in recent years. These "operations that encompass the use of military capabilities across the range of military operations short of war"[10] frequently feature the employment of SOF assets.

Precision Engagement. The *CFJO* defines precision engagement as "a system of systems that enables our forces to locate the objective or target, provide responsive

command and control, generate the desired effect, assess our level of success, and retain the flexibility to reengage with precision when required."[11]

Special Operations. Special operations refers to those military operations "conducted by specially organized, trained, and equipped military and paramilitary forces to achieve military, political, economic, or psychological objectives by unconventional military means in hostile, denied, or politically sensitive areas. . . . Special operations differ from conventional operations in degree of physical and political risk, operational techniques, mode of employment, independence from friendly support, and dependence on detailed operational intelligence and indigenous assets."[12]

Special Operations Forces. Special operations forces are "those active and reserve component forces of the military services designated by the Secretary of Defense and specifically organized, trained, and equipped to conduct and support special operations."[13]

Unified Combatant Command. U.S. military operations are conducted by unified combatant commands which have "a broad continuing mission under a single commander and [are] composed of significant assigned components of two or more Military Departments."[14]

United States Special Operations Command. United States Special Operations Command is one of the nine unified combatant commands in the DOD and oversees all SOF assets in the DOD. Among its many responsibilities, USSOCOM is charged with funding and managing the development, acquisition, and support of SOF-unique material systems and equipment, many of which are installed on AC-130 gunships.

Limitations

The timeframe used throughout this thesis is the year 2010, as this is the reference period indicated in *JV 2010*. Though *JV 2010* is the overarching DOD vision for the future of warfighting, a number of conventional service and SOF publications used in this effort base their future warfighting strategies on timeframes other than the year 2010. Where possible, applicable portions of these publications which relate to the 2010 timeframe are used.

This thesis presents in-depth analyses related to the *JV 2010* concept of precision engagement. However, due to the relative newness of *JV 2010*, the DOD is still in the process of fully understanding, refining, and implementing the new warfighting concepts presented in *JV 2010*. As such, the body of works which describe specific precision engagement-related mission tasks and material requirements is somewhat limited. This study focuses primarily on information produced subsequent to the July 1996 release of *JV 2010*. In some cases, drafts of official documents undergoing coordination prior to release are used.

This thesis presents only unclassified information. Given the fact that many special operations missions involve highly sensitive or classified activities, this thesis will describe SOF capabilities only in unclassified, general terms which are publicly acknowledged. Similarly, many of the required precision engagement technologies and material systems indicated in chapter 4 of this thesis may involve classified properties and capabilities. Only unclassified information will be used to describe these material technologies and systems.

Delimitations

This study limits the analysis of precision engagement mission tasks and material requirements to the AC-130 and gunship operations. Though much of the data presented in this thesis may be relevant to weapon systems other than the AC-130, no attempt is made to describe or analyze precision engagement requirements potentially applicable to other DOD precision engagement platforms.

This thesis focuses on the *JV 2010* concept of precision engagement as it applies to the AC-130 gunship. Though the three additional warfighting concepts described in *JV 2010*—dominant maneuver, full-dimension protection, and focused logistics all have applicability to future gunship operations and requirements, this thesis presents the results of analyses related solely to precision engagement operations.

In a similar vain, many other factors influence the ability of AC-130 gunships to deliver precision firepower during military operations, such as crew qualification and other on-board hardware and software systems. To fully describe every possible factor which may influence the ability of this aircraft to provide effective, precision fire support in the 2010 timeframe is beyond the scope of this effort.

This thesis presents the results of an unconstrained exploration of precision engagement technologies potentially applicable for use on AC-130 gunships. The recommended material systems and capabilities identified in chapter 4 of this thesis are not prioritized in any manner, nor do they consider any technical or fiscal constraints which may limit, delay, or prevent their implementation on AC-130 gunships.

[1]General John M. Shalikashvili, *Joint Vision 2010*, July 1996, 1-2; in *Joint Electronic Library* [CD-ROM] (Washington, DC: Joint Staff, May 1997).

[2]Ibid.

[3]Ibid., 2.

[4]Commander, Joint Warfighting Center, *Concept for Future Joint Operations*, May 1997, Foreword; in *Joint Electronic Library* [CD-ROM] (Washington, DC: Joint Staff, May 1997).

[5]Department of Defense, Joint Publication 1-02, *DOD Dictionary*, April 1997, 98; in *Joint Electronic Library* [CD-ROM] (Washington, DC: Joint Staff, May 1997).

[6]Ibid., 130.

[7]Commander, Joint Warfighting Center.

[8]Ibid., 2

[9]Department of Defense, Joint Publication 1-02, 286.

[10]Ibid., 339.

[11]Commander, Joint Warfighting Center, 2.

[12]Department of Defense, Joint Publication 1-02, 494.

[13]Ibid.

[14]Ibid., 560.

CHAPTER 2

LITERATURE REVIEW

Overview

In order to answer the research questions established in chapter 1, it was necessary to review and analyze a number of publications related to national military strategy, twenty-first century joint warfare, precision engagement operations, and DOD science and technology activities. The May 1997 version of the *Joint Electronic Library* (*JEL*) CD-ROM provided an excellent starting point in the search for information related to this research topic. The *JEL* contained many key documents which proved essential to the research effort, including *Joint Vision 2010*, the Joint Warfighting Center's *Concept for Future Joint Operations*, each military service's twenty-first century vision statement, and Joint Chiefs of Staff (JCS) doctrinal publications related to this topic.

The second principle source of literature was the Internet, where online searches of numerous DOD electronic libraries yielded a wealth of data related to *JV 2010* and the precision engagement concept. The *Defenselink* Internet site (http://www.defenselink.mil) provided links to numerous DOD electronic libraries which contained documents related to this topic. Electronic libraries visited during the course of research included those at the Defense Technical Information Center, the National Defense University, the Army War College, Fort Leavenworth's Combined Arms Research Library and Center for Army Lessons Learned, the Naval War College, the Naval Doctrine Center, Marine Corps University, the Marine Corps Concept Development Command, Air University, the Air

Force Doctrine Center, the Defense Advanced Research Projects Agency, and the Institute for National Strategic Studies.

The collective body of publications gathered from the *JEL* and DOD electronic libraries provided three overarching functions during the course of this research effort. First, they verified DOD-wide interest in *JV 2010*'s new warfighting concepts, thus validating the significance of this study. Second, they validated my selection of subordinate research areas and questions. Finally, they formed the foundation upon which conclusions related to the primary and subordinate research areas were drawn.

The literature obtained and analyzed in support of this thesis fell into three general categories of information: national military strategy documents, JCS, service, and SOF publications which describe the nature of twenty-first century warfare, and DOD science and technology planning documents. This collective body of works is illustrated in figure 1. Subsequent sections in this chapter describe the nature of these publications and show how each of these works contributed to the research effort.

National Military Strategy Publications

As indicated in chapter 1, the foremost subordinate research area in this thesis focuses on understanding the role of *JV 2010* in U.S. national military strategy. Three documents recently published by America's most senior military leaders provided insight into this area by identifying America's long-term national security goals and the role *JV 2010* will play in support of DOD efforts to secure these vital national interests.

In May 1997, Secretary of Defense William S. Cohen released the *Report of the Quadrennial Defense Review* (*QDR*). In the *QDR* report, Secretary Cohen describes the

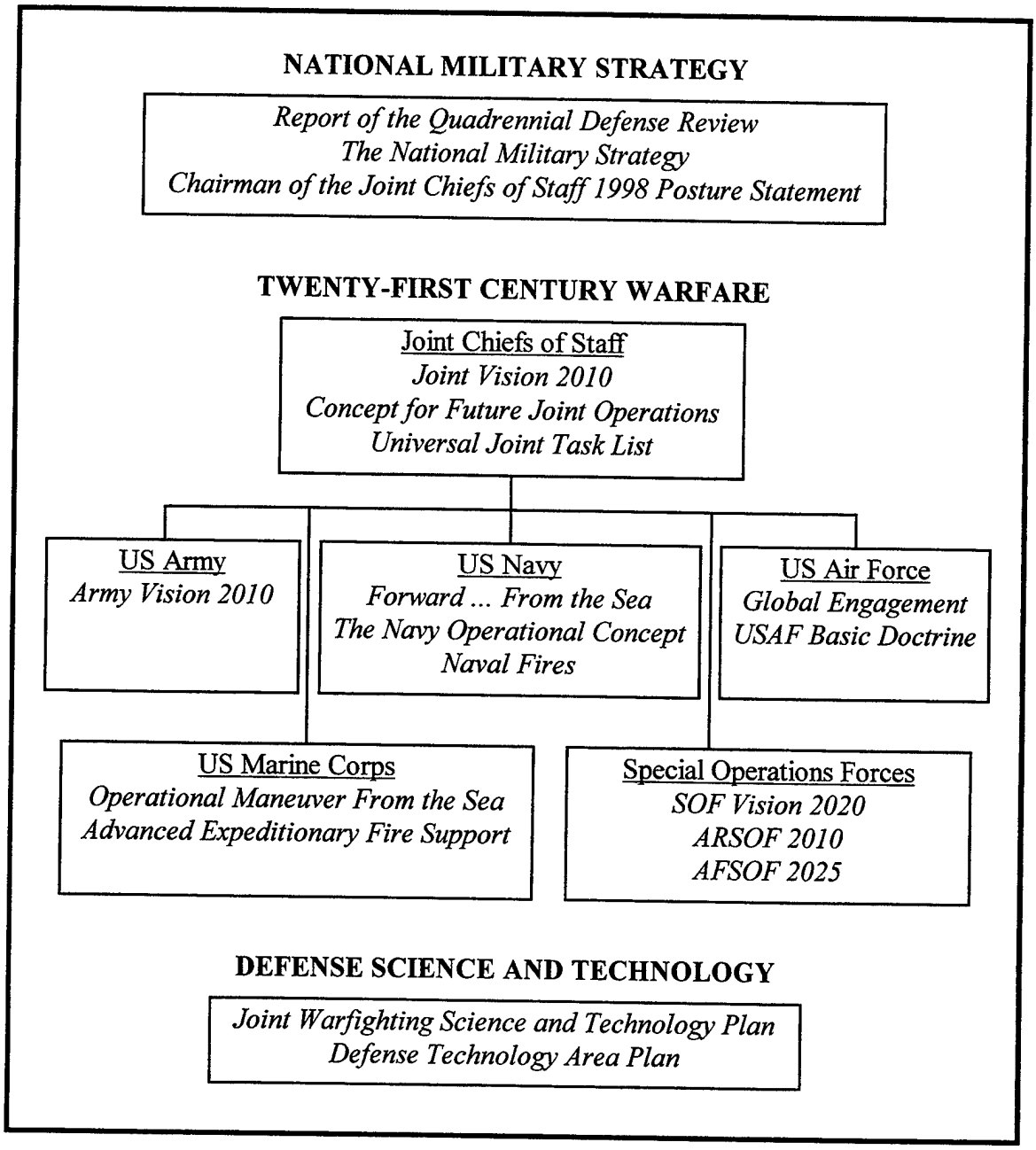

Figure 1. Precision Engagement-Related Literature

fundamental elements of America's national military strategy and indicates how our armed forces should be organized, trained, and equipped to achieve these long-term national security interests. The Secretary also cites the critical importance of *JV 2010* in national

military strategy, describing it as the guide by which America's armed forces will transform themselves in ways which support twenty-first century national security requirements.[1] In the *QDR* report, Secretary Cohen makes numerous specific references to *JV 2010* and the new warfighting concepts contained therein. Included among these citations is Secretary Cohen's description of how precision engagement platforms will support future military operations.[2] With regard to this effort, the *QDR* provided the fundamental background information needed to understand national security objectives and assess the warfighting capabilities that precision engagement platforms will have to provide during future military conflicts.

In the 1997 version of *The National Military Strategy* (*NMS*), former Chairman of the Joint Chiefs of Staff (CJCS) General John M. Shalikashvili established the long-term, strategic direction for America's armed forces in support of the national security objectives outlined by Secretary Cohen in the *QDR*. In the *NMS*, General Shalikashvili describes how *JV 2010* and its new warfighting principles will form the basis for a twenty-first century transformation of America's military forces.[3] Like the *QDR*, the *NMS* provided valuable insight into our national security interests and the required warfighting capabilities needed to achieve these objectives.

In his February 1998 statement to Congress, current CJCS General Henry H. Shelton expands upon the themes presented in the *QDR* and *NMS*. In this document, General Shelton describes the current posture of America's armed forces, and outlines his plan for the modernization of present-day military forces and equipment. Among his points, General Shelton highlights the important role that *JV 2010* will play in future DOD

modernization strategies, describing it as the foundation upon which future DOD equipment modernization strategies will be based.[4]

Twenty-First Century Warfare Publications

The second principle element of the research effort centers on understanding twenty-first century warfare and the employment of precision engagement systems in support of future military operations. A number of documents related to this subject were reviewed and analyzed during the course of this effort. Collectively, this body of works provided the fundamental information needed to isolate and assess the specific warfighting concepts inherent in precision engagement operations. The works described below were instrumental in determining the specific mission requirements and tasks which comprise precision engagement operations.

JCS Publications

As indicated in chapter 1 of this thesis, *Joint Vision 2010* is the conceptual template which describes the new warfighting principles that will characterize twenty-first century military operations. Among its many purposes, *JV 2010* provides common direction to the armed services as they develop the advanced technologies and material systems needed to meet the national security objectives described in the *QDR* and *NMS*.[5] As it pertained to this effort, *JV 2010* provided a fundamental understanding of future military operating environments and the technological trends which will have long-term implications for DOD weapon systems like the AC-130 gunship. *JV 2010* provided the starting point for subsequent detailed analyses which developed the precision engagement concept as it applies to the AC-130 gunship.

The Joint Warfighting Center's *Concept for Future Joint Operations* provided additional information regarding precision engagement operations and mission requirements. As the first step in the *JV 2010* implementation process, the *CFJO* provides a roadmap for the military services and unified combatant commands to further develop, refine, and implement the new warfighting concepts presented in *JV 2010*.[6] With regard to this effort, the *CFJO* provided a more detailed understanding of precision engagement operations and the core capabilities that precision engagement platforms will have to provide during future military operations.

Chairman of the Joint Chiefs of Staff Manual (CJCSM) 3500.04B, *Universal Joint Task List* (*UJTL*), was an especially valuable resource in this research effort. The *UJTL* contains a comprehensive listing of the mission tasks which must be performed by military forces during warfare. The *UJTL* served two primary purposes in this effort: it offered insight into the specific military tasks which comprise modern warfare, and it provided a backdrop against which specific tactical-level precision engagement mission tasks could be developed and analyzed. The development of these mission tasks proved to be the cornerstone of this research effort.

U.S. Army Publications

Army Vision 2010 is the U.S. Army's overarching vision for the future of land warfare. Included among the six "patterns of operation" contained in *Army Vision 2010* is a concept the Army refers to as "shaping the battlespace." This pattern of operation closely aligns with the precision engagement concept as described in *JV 2010* and the *CFJO*.[7] *Army Vision 2010* provided an understanding of how the Army intends to apply

the new warfighting concepts indicated in *JV 2010*. Its description of shaping the battlespace provided the Army's perspective on the required capabilities that precision engagement platforms will have to provide in support of land-based forces.

U.S. Navy Publications

Three U.S. Navy publications provided the information needed to assess the capabilities that precision engagement systems must provide to future maritime forces. First among these documents is *Forward . . . From the Sea*, which outlines the Navy's vision for the future of naval warfare. This document provided a general overview of the operational environments in which naval forces will conduct future maritime operations.

In a March 1997 essay entitled *The Navy Operational Concept*, Chief of Naval Operations Admiral Jay L. Johnson further expands upon the warfighting principles outlined in *Forward . . . From the Sea*. In this work, Admiral Johnson describes the required characteristics of future naval fire support systems. This document provided valuable insight into how the Navy envisions the employment of precision fire support systems in support of future maritime warfare.

An October 1997 concept paper produced by the Naval Doctrine Center provided still further insight into the required capabilities that precision fire support systems will need in order to support future maritime operations. In this concept paper, entitled *Naval Fires: A Concept for Seabased Warfighting in the 21st Century*, the author describes how naval and joint fire support systems must interact with one another in order to provide integrated, overwhelming firepower in support of land- and sea-based maneuver forces.[8]

U.S. Marine Corps Publications

Operational Maneuver from the Sea (*OMFTS*) outlines the future roles and missions for Marine Corps forces. Among its many tenets, *OMFTS* includes a description of the important roles that precision fire support platforms will play in support of future Marine Corps operations.[9] This document provided the Marine Corps' perspective on future precision firepower requirements.

Like their Navy brethren, the Marine Corps Concept Development Command (MCCDC) recently published a concept paper which expands the Corps' thinking about future precision fire support systems. In *Advanced Expeditionary Fire Support: The System After Next*, the author describes how an advanced, integrated network of land-based, sea-based, and airborne fire support systems must support future amphibious operations.[10] This paper provided additional insight regarding the Marine Corps' philosophy on the employment of precision engagement systems in the next century.

U.S. Air Force Publications

The U.S. Air Force's overarching vision of twenty-first century aerial warfare is contained in *Global Engagement: A Vision for the 21st Century Air Force*. *Global Engagement* provides a comprehensive overview of the methods by which the USAF intends to control and exploit the air and space aspects of future warfare. *Global Engagement* outlines six "core competencies" that will characterize USAF operations in the twenty-first century. One of these six core competencies, "precision engagement," directly ties to the *JV 2010* operational concept of precision engagement.[11] *Global Engagement*'s portrait of future Air Force precision engagement operations provided a

fundamental backdrop for assessing the capabilities that AC-130 gunships will need in order to support twenty-first century military operations.

Expanding upon the concepts presented in *Global Engagement*, Air Force Doctrine Document 1 (AFDD 1), *Air Force Basic Doctrine*, provides a doctrinal foundation for the employment of airpower in support of joint military operations. AFDD 1 provided further evidence of the required capabilities that future Air Force precision engagement systems will need in order to conduct military operations in the next century.

SOF Publications

SOF Vision 2020 (*SOF 2020*) is the long-range vision statement of the United States Special Operations Command. *SOF 2020* presents USSOCOM's perspective on the broad, strategic warfighting concepts that will characterize SOF employment during future military operations. With regard to this research effort, *SOF 2020* provided USSOCOM's perspective on the employment of precision engagement platforms in support of twenty-first century special operations missions.

The U.S. Army Special Operations Command's long-range vision publication *Army Special Operations Forces 2010* (*ARSOF 2010*) provided further insight into the essential capabilities that precision engagement platforms, such as the AC-130, must provide in support of future special operations missions.

Air Force Special Operations Forces 2025 (*AFSOF 2025*) outlines the modernization requirements for Air Force Special Operations Command weapon systems, including AC-130 gunships. *AFSOF 2025* provided AFSOC's perspective on the required

capabilities that future AFSOC precision engagement systems must provide in order to support future SOF operations. Additionally, *AFSOF 2025*'s description of the AFSOC modernization planning process provided the basis for the research methodology used in this thesis.

Defense Science and Technology Publications

The final subordinate research area focuses on determining the material systems and capabilities required to conduct precision engagement operations. Two DOD science and technology planning documents provided the critical sources of information needed to conduct the investigation in this area. The two works described below provided insight into precision engagement-related material technologies currently under investigation within the DOD.

The *Joint Warfighting Science and Technology Plan* (*JWSTP*) provides a unified focus for DOD research and development activities related to the new warfighting principles outlined in *JV 2010*.[12] A critical element of this research project, the *JWSTP* provided joint warfighting capability objectives related to the precision engagement mission tasks derived from JCS, service, and SOF publications.

The *Defense Technology Area Plan* (*DTAP*) presents DOD technology development efforts related to the warfighting capability objectives outlined in the *JWSTP*.[13] The *DTAP* provided valuable insight regarding specific performance objectives of material systems needed to conduct precision engagement operations.

Summary

The literature reviewed and analyzed during the course of this research project contained a wealth of data related to the *JV 2010* operational concept of precision engagement. The various works described above revealed the important roles that precision firepower systems will play in future national security strategies and military operations. The literature utilized in support of this thesis more than adequately provided the ability to answer the research questions outlined in chapter 1.

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[1]Honorable William S. Cohen, *Report of the Quadrennial Defense Review*, May 1997 [document on-line]; available from http://www.defenselink.mil/pubs/qdr; Internet.

[2]Ibid.

[3]General John M. Shalikashvili, *The National Military Strategy*, October 1997 [document on-line]; available from http://www.dtic.mil/jcs/nms; Internet.

[4]General Henry H. Shelton, *Posture Statement by General Henry H. Shelton, Chairman of the Joint Chiefs of Staff, before the 105th Congress, Senate Armed Services Committee, United States Senate*, 3 February 1998 [document on-line]; available from http://www.dtic.mil/jcs/chairman/shelton/98posture.pdf; Internet.

[5]General John M. Shalikashvili, *Joint Vision 2010*, July 1996; in *Joint Electronic Library* [CD-ROM] (Washington, DC: Joint Staff, May 1997).

[6]Commander, Joint Warfighting Center, *Concept for Future Joint Operations*, May 1997; in *Joint Electronic Library* [CD-ROM] (Washington, DC: Joint Staff, May 1997).

[7]General Dennis J. Reimer, *Army Vision 2010*, November 1996; in *Joint Electronic Library* [CD-ROM] (Washington, DC: Joint Staff, May 1997).

[8]Major Tom Soroka, *Naval Fires: A Concept for Seabased Warfighting in the 21st Century*, 31 October 1997 [document on-line]; available from http://ndcweb.navy.mil/concepts/navfire/NFDRFSP7.htm; Internet.

[9]General Charles C. Krulak, *Operational Maneuver From The Sea*, 1996; in *Joint Electronic Library* [CD-ROM] (Washington, DC: Joint Staff, May 1997).

[10]Major Matthew Bragg, *Advanced Expeditionary Fire Support: The System After Next*, 9 January 1998 [document on-line]; available from http://ismo-www1.mqg.usmc.mil/concepts/advfires.htm; Internet.

[11]General Ronald R. Fogleman, *Global Engagement: A Vision for the 21st Century Air Force*, October 1996; in *Joint Electronic Library* [CD-ROM] (Washington, DC: Joint Staff, May 1997).

[12]Department of Defense, Director of Defense Research and Engineering, *Joint Warfighting Science and Technology Plan*, January 1997 [document on-line]; available from http://www.dtic.mil/dstp/DSTP/97_jwstp/jwstp.htm; Internet.

[13]Department of Defense, Director of Defense Research and Engineering, *Defense Technology Area Plan*, January 1997 [document on-line]; available from http://www.dtic.mil/dstp/DSTP/97_dtap/dtap.htm; Internet.

CHAPTER 3

RESEARCH METHODOLOGY

Introduction

What kinds of material systems and capabilities should be installed on AC-130 gunships in order for this aircraft to provide effective, precision fire support in the 2010 timeframe? The overarching methodology used to answer this primary research question was that of a strategy-to-task-to-need approach. The descriptive and comparative research methods were also employed in the examination of subordinate research areas. The combination of these two classic research methods with the strategy-to-task-to-need approach permitted detailed analysis of literature related to this topic, validated and generated answers to the primary and subordinate research questions, and ultimately led to conclusions and recommendations related to this topic.

Research Methodology

The strategy-to-task-to-need analysis methodology employed in this thesis traces a top-down progression through the hierarchy of military strategy, doctrine, and future warfare publications illustrated in chapter 2 (figure 1). As the primary research question underlying this thesis was derived from the *JV 2010* concept of precision engagement, the analysis began with a descriptive review of literature related to this concept. Current national military strategy documents were analyzed in detail in order to assess the role of *JV 2010* and the precision engagement concept in national-level security strategy. The relationships between *JV 2010* and national security policy provided an intellectual

foundation for further analysis of the warfighting roles and requirements for precision engagement platforms like the AC-130 gunship.

Next, the role of precision firepower in future warfighting scenarios was examined via detailed analysis of JCS, conventional military service, and SOF publications which paint the picture of twenty-first century warfare. Analyses in this area determined how the services and SOF envision the employment of precision engagement systems during future military operations. *JV 2010* and the Joint Warfighting Center's *Concept for Future Joint Operations* provided the starting points for this task, offering insight into the precision engagement concept and its role in future joint warfighting strategy. Then, a comparative analysis of various service and SOF vision statements and concept papers yielded a common set of warfighting characteristics embedded in the precision engagement concept. This comparison considered each organization's anticipated wartime roles, missions, and requirements for precision fire support during future military conflicts. The common precision engagement themes resulting from this comparison formed the basis for subsequent analyses which determined specific precision engagement-related mission tasks and material requirements.

Specific precision engagement-related mission requirements and tasks were derived from the common characteristics of future precision engagement operations embedded in JCS, service, and SOF vision publications. Included in this analysis was an examination of how future military operating environments and battlefield conditions might influence the accomplishment of precision engagement mission tasks. Once known, these precision engagement mission tasks led to the final research effort—determining the

kinds of material systems, equipment, and capabilities needed to conduct precision engagement operations.

Detailed analysis of current DOD science and technology planning documents yielded numerous advanced material requirements and technology objectives related to the precision engagement concept. Based upon the precision engagement tasks and technology objectives derived from current military strategy, doctrine, and technology planning documents, three categories of specific AC-130 precision engagement material needs were subsequently developed. The material needs and capabilities indicated in this portion of the analysis provide answers to the primary research question.

Rationale

Air Force Special Operations Forces (AFSOF) modernization initiatives are guided by the formal USAF modernization planning process (MPP). The USAF MPP is the prescribed methodology for determining current and future Air Force missions, tasks, material needs, and deficiencies.[1] The AFSOC MPP looks twenty-five years into the future and attempts to define the AFSOF missions, warfighting tasks, forces, and material systems needed to respond to future warfighting challenges. This process and its results are documented in AFSOC's long-range planning document entitled *Air Force Special Operations Forces 2025*. Specific AC-130 gunship modernization and material requirements are described in the Precision Engagement/Strike Mission Area Plan (MAP) contained within *AFSOF 2025*.

AFSOC conducts its MPP biennially in conjunction with the beginning of each iteration of the DOD Planning, Programming, and Budgeting System (PPBS). The

AFSOC MPP uses a strategy-to-task-to-need approach to link national military strategies to USSOCOM and USAF mission tasks, then to required AFSOF capabilities and material needs. By comparing current AFSOF capabilities to those required in the future, AFSOC generates a list of weapon system deficiencies and material requirements. This list of material deficiencies is then prioritized and forwarded to various DOD laboratories, system program offices, logistics centers, and civilian contractors for identification of potential material solutions to these needs. This strategy-to-task-to-need framework allows AFSOC planners to systematically and logically derive material needs from fundamental national security interests and goals.[2] As the intent of this thesis is to assist AFSOC planners in this process, specifically in regard to future AC-130 gunship modernization requirements, the research methodology used in this thesis logically follows this same strategy-to-task-to-need approach.

Summary

The combination of two classic research methods with the strategy-to-task-to-need approach provided a logical framework for the research and analyses required to complete this thesis. Current DOD, JCS, service, and SOF publications related to the precision engagement concept were tied together and examined for answers to the subordinate research questions. Comparing the similarities between these publications led to an in-depth understanding of future warfighting scenarios, the role of precision firepower in these future scenarios, and the required mission tasks that precision engagement platforms like the AC-130 gunship will be called upon to perform during future military conflicts. Once these tasks were known, a review of on-going and planned DOD technology

initiatives related to the precision engagement concept led to the identification of potential material technologies which could be directly applied or adapted for use on AC-130 gunships, thereby enabling the aircraft to provide effective, precision fire support in the 2010 timeframe.

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[1]Commander, Air Force Special Operations Command, *Air Force Special Operations Forces 2025* (Hurlburt Fld, FL: HQ AFSOC/XP, 1 November 1997), 1-1 - 1-2.

[2]Ibid., 1-2 - 1-3.

CHAPTER 4

ANALYSIS

Introduction

This chapter presents the results of my investigation into the *Joint Vision 2010* concept of precision engagement and its impact on future AC-130 gunship modernization requirements. The first section of this chapter focuses on the importance of *JV 2010* and the precision engagement concept in current-day American military strategy. Next, the role of precision firepower in future military conflicts is analyzed using JCS and military service vision publications which paint the picture of twenty-first century warfare. Specific precision engagement concepts are then derived from these futuristic warfighting scenarios. Subsequent sections then present specific precision engagement-related military requirements and mission tasks developed from these concepts and current JCS doctrine. Operational employment conditions which may influence the accomplishment of these tasks are also presented. Finally, DOD science and technology planning documents are analyzed for material technologies related to these precision engagement tasks and employment conditions. AC-130 gunship modernization requirements are subsequently derived from these precision engagement-related technology objectives.

Precision Engagement in National Military Strategy

Prerequisite to determining the material requirements for twenty-first century precision engagement platforms like the AC-130 gunship is the need to understand the role and importance of *JV 2010* and the precision engagement concept in American national military strategy. Several recent publications produced by Secretary of Defense

William S. Cohen and Chairmen of the Joint Chiefs of Staff General John M. Shalikashvili and General Henry H. Shelton provide insight into this area.

The Secretary of Defense

The long-term strategic importance of *JV 2010* and the new warfighting concepts contained therein are outlined in Secretary of Defense (SECDEF) Cohen's May 1997 *Report of the Quadrennial Defense Review.* In the *QDR*, Secretary Cohen describes the fundamental element of the DOD's current military strategy—the need to effectively shape and respond to military challenges in the near term while simultaneously transforming America's armed forces to effectively respond to military crises in the 2010 timeframe and beyond. The Secretary fully embraces *JV 2010* in the *QDR*, citing its critical importance as the guide by which this transformation of the armed forces is to be conducted. The *QDR* report also highlights the importance of *JV 2010*'s four new operational concepts (dominant maneuver, precision engagement, full-dimension protection, and focused logistics) as the focus of DOD preparations to meet future warfighting challenges.[1]

In the *QDR* report, Secretary Cohen describes the nature of future precision engagement operations, saying "Precision engagement will enable U.S. forces to deliver the desired effects at the right time and place on any target. Having near-real-time information about the target, a common awareness of the battlespace for responsive command and control, and the flexibility to reengage with precision, U.S. forces will be able to destroy key nodes of enemy systems at great distances with fewer munitions and less collateral damage."[2]

Secretary Cohen also describes the nature of future precision engagement systems as "more capable attack platforms and advanced weapons and munitions."[3]

In the *QDR* report, SECDEF Cohen cites several examples of on-going DOD acquisition programs aimed at providing such precision firepower capabilities, including the F/A-18E/F and F-22 advanced fighter aircraft, the RAH-66 and AH-64D attack helicopters, advanced field artillery systems, and a number of on-going advanced weapons and munitions programs. In addition to these lethal weapons systems, Secretary Cohen also highlights the critical importance of precise, nonlethal weapons for use in military operations other than war, such as noncombatant evacuation operations (NEOs) and peacekeeping operations.[4]

Chairmen of the Joint Chiefs of Staff

In the 1997 version of *The National Military Strategy*, former CJCS General John M. Shalikashvili underscores many of the national security objectives outlined by SECDEF Cohen in the *QDR*. In the *NMS*, General Shalikashvili echoes the importance of *JV 2010* and the precision engagement concept in securing America's long-term national security interests.

Per the *NMS*, current American national military strategy consists of three essential elements:

1. Shaping the International Environment
2. Responding to the Full Spectrum of Crises
3. Preparing Now for an Uncertain Future

In describing the latter element of America's national military strategy, preparing now for an uncertain future, General Shalikashvili refers to *JV 2010* as "the vision of future capabilities that guides our warfighting requirements and procurement, and focuses technological development."[5]

"Developing and fielding modern, next-generation systems and technologies . . . will be the key to fielding a strong, capable Joint Force in the next century."[6] So says current CJCS General Henry H. Shelton in his February 1998 statement to Congress describing the posture and direction of America's armed forces. In this report, General Shelton highlights the importance of *JV 2010* in the DOD's force modernization strategy, saying "Our modernization efforts hinge on *Joint Vision 2010*, our operational template for future joint operations."[7]

As evidenced by the words of America's most senior military leaders, *JV 2010* and the precision engagement concept will play vital roles in future national security strategy by shaping the links between national military strategy and the means by which security objectives are achieved. Given *JV 2010*'s role in national military strategy, the focus of attention now turns toward understanding the warfighting roles and missions of future precision engagement systems.

Precision Engagement in Future Military Conflicts

As the primary research question underlying this thesis was derived from the *JV 2010* operational concept of precision engagement, it is necessary to examine the tenets of this concept in detail and in light of the future warfighting scenarios envisioned by the armed forces.

Precision Engagement Defined

JV 2010 defines precision engagement as "a system of systems that enables our forces to locate the objective or target, provide responsive command and control, generate the desired effect, assess our level of success, and retain the flexibility to reengage with precision when required."[8] However, this definition of precision engagement is little more than a broad statement of general military capabilities. In order to understand this broad requirement and determine its relationship to future precision engagement material systems, it is necessary to explore the precision engagement concept in greater detail. The Joint Warfighting Center's *Concept for Future Joint Operations* provides the starting point for this task.

The *CFJO* indicates that precision engagement operations will focus primarily on the battlefield effects inflicted upon enemy forces and equipment, not necessarily the means by which these effects are applied. According to the *CFJO*, precision engagement encompasses more than just attacking targets with advanced, high technology munitions. It incorporates a much broader range of military capabilities provided by military forces (people), battlefield targeting systems, and communications and information systems. For each military situation across the spectrum of conflict from major theater war (MTW) to military operations other than war, this broad range of precision engagement assets would be tailored and employed based on the joint force commander's assessment of the required operational effects needed to achieve desired battlefield results. These tailored capabilities would then be used at critical times and points on the battlefield in order to secure quick, decisive victory over the enemy.[9]

The *CFJO* identifies six core warfighting concepts embedded in precision engagement operations. These concepts are:

1. The ability for responsive, multidimensional engagement that matches capabilities to desired effects in any operation across the range of military activities.

2. A flexible, time-critical targeting architecture that includes rapid identification and continuous, real-time sensor-to-shooter links.

3. Well-equipped forces with agile platforms and lethal munitions.

4. The ability to engage targets more responsively and accurately from increasingly longer ranges.

5. The ability to minimize collateral damage through precise targeting and accurate, effective delivery systems and munitions.

6. The ability to provide precise, immediate combat/operational assessment and to rapidly reengage if required.[10]

Service Perspectives on Precision Engagement

Given the AC-130 gunship will continue to be tasked in support of conventional and SOF assets resident to all four branches of the military, it is vital to understand how each military service and the special operations community envisions the employment of precision engagement systems as an element of military operations in the 2010 timeframe. Subsequent paragraphs describe service and SOF views on the roles, missions, and employment of precision engagement systems in future warfare.

U.S. Army

Army Vision 2010 is the U.S. Army's overarching vision for the future of land warfare. It is the blueprint for Army contributions to future joint warfare and the operational concepts identified in *JV 2010*. In it, Army Chief of Staff General Dennis J. Reimer describes six "patterns of operation" which will characterize Army operations during future military conflicts. These six patterns of operation are directly linked to *JV 2010*'s new operational concepts, with the operational pattern termed "shaping the battlespace" most closely aligning to *JV 2010* and *CFJO* descriptions of the precision engagement concept.[11]

According to *Army Vision 2010*, shaping the battlespace is defined as the integration of combat multipliers such as precision fire support with the maneuver of land-based combat forces. Effective battlespace shaping will allow Army commanders to properly position their forces and take advantage of the environment (terrain, infrastructure, weather) in ways which enable decisive and overwhelming engagement of opposing enemy land forces. The goal of this operational pattern is to eliminate the enemy's warfighting capabilities and degrade his will to fight prior to the commitment of land forces to close combat operations, thus minimizing potential friendly casualties. In this scenario, precision strikes by fire support assets such as field artillery systems, attack helicopters, and combat aircraft are used to enable the land component commander to control the timing and tempo of the land battle. *Army Vision 2010*'s description of shaping the battlespace includes many of the key precision engagement concepts outlined in the *CFJO*: precise, accurate battlefield intelligence; precision target detection,

identification, and tracking; simultaneous application of joint combined arms capabilities; real-time battlefield information transfer via sensor-to-shooter links; increased lethality at extended ranges; and precision fire support platforms capable of delivering both lethal and nonlethal munitions.[12]

U.S. Navy

Forward . . . From the Sea is the Navy's vision of future naval warfare. It addresses the Navy's contribution to national security by describing the roles and missions of naval forces in future joint warfare. As this document was published nearly two years prior to *JV 2010*, it does not directly link future naval fire support capabilities and requirements to the *JV 2010* precision engagement concept. This document does, however, describe the general operational context in which fire support systems are to be employed during future maritime warfare.

In a March 1997 essay entitled *The Navy Operational Concept*, Chief of Naval Operations (CNO) Admiral Jay L. Johnson expands upon the concepts in *Forward . . . From the Sea* and establishes the links between future Navy capabilities and *JV 2010*. Included among Admiral Johnson's thoughts is the role of precision naval firepower in support of twenty-first century maritime operations. Paralleling the *JV 2010* concept of precision engagement, Admiral Johnson presents the key required characteristics of future naval fire support systems: have the desired effect on the enemy; perform "smart targeting"; deliver extremely accurate and lethal munitions from extended ranges; limit collateral damage; and lessen the risk to land forces.[13]

Based on the future warfighting principles established in *Forward . . . From the Sea* and *The Navy Operational Concept*, a recent Naval Doctrine Center concept paper entitled *Naval Fires: A Concept for Seabased Warfighting in the 21st Century* offers even more insight into the roles precision engagement systems will have in support of naval operations in the next century. This work cites the importance of integrating joint fire support systems in support of maritime operations. According to *Naval Fires*, the integration of mutually reinforcing and complimentary joint fire support systems will be vital in order to achieve overwhelming battlefield effects. Extensive information sharing among all forces involved in the battle will be required in order to properly time and locate precision firepower, thereby avoiding fratricide and duplication of effort. This concept paper articulates the primary requirement for future naval fire support systems as the ability to simultaneously integrate and apply precision firepower in concert with the maneuver of land or sea-based forces.[14]

U.S. Marine Corps

The Marine Corps' long-range vision publication, *Operational Maneuver From The Sea*, outlines the roles and missions of Marine Corps forces in future maritime operations. Though published prior to *JV 2010*, the future warfighting principles described in *OMFTS* generally align with those in *JV 2010* and the *CFJO*. Among the many warfighting requirements contained in *OMFTS*, the Marine Corps specifically cites the importance of precision fire support systems in their future operations. Like the other services, the Marines seek enhanced, streamlined fire support coordination measures between weapons delivery platforms and their surface maneuver forces. In *OMFTS*, the

Marines also highlight the need for fire support platforms to deliver more accurate and more lethal ordnance from increased ranges.[15]

Like their Navy counterparts, the Marine Corps Concept Development Command is expanding upon the operational concepts described in *OMFTS*. A recent MCCDC concept paper further articulates the Marine Corps' need for, and planned employment of advanced fire support systems in twenty-first century maritime operations. In *Advanced Expeditionary Fire Support: The System After Next*, author Major Matthew Bragg details a Marine Corps concept for an advanced, integrated fire support network consisting of land-based, sea-based, and airborne fire support systems. The paper describes the required characteristics of this network of precision fire support systems: real-time data links between target acquisition systems, ground forces, and weapons delivery systems; complementary sources of firepower with mutually supporting capabilities; and the ability to deliver lethal and nonlethal precision weapons against a broad target set in all-weather conditions and from extended ranges. Included in this concept is the Marine Corps' description of how airborne precision engagement systems are to help shape the ground commander's battlespace via CAS and deep interdiction attacks. Additionally, in this concept paper the Marine Corps places special emphasis on the need to deliver nonlethal ordnance in support of MOOTW.[16]

U.S. Air Force

The U.S. Air Force's overarching vision of twenty-first century aerial warfare is described in *Global Engagement: A Vision for the 21st Century Air Force*. In *Global Engagement*, former USAF Chief of Staff General Ronald R. Fogleman defines six "core

competencies" which will characterize USAF operations in the next century, one of which being "precision engagement." With its definition firmly rooted in *JV 2010*, the Air Force core competency of precision engagement includes the ability to apply selective force against specific targets to achieve discrete and discriminating battlefield effects while minimizing risk and collateral damage to noncombatant personnel and property.[17]

Air Force Doctrine Document 1, *Air Force Basic Doctrine*, is the USAF's capstone doctrinal publication and also serves to expand the precision engagement concept with regard to future aerial warfare. Echoing *JV 2010* and the *CFJO*, AFDD 1 places special emphasis on the effects of precision force applied across the spectrum of military conflict and enemy targets rather than the means by which these effects are delivered. According to AFDD 1, superior situational awareness and the ability to attack any facet of the enemy's power will be vital to future precision engagement operations. AFDD 1 also describes precision engagement as including the ability to deliver nonlethal force in addition to traditional lethal munitions.[18]

Special Operations Forces

SOF Vision 2020 is the long-range vision statement of the United States Special Operations Command. Though it makes reference to the new operational concepts contained in *JV 2010*, *SOF 2020* does not detail the role of precision engagement systems in support of future SOF operations. Rather, *SOF 2020* outlines broad, strategic warfighting concepts that will dominant SOF employment in future warfare. *SOF 2020* suggests a broad requirement for precision engagement systems needed to support twenty-first century special operations, stating "future [SOF] forces must possess the capability to

execute [mission] tasks with enhanced lethality, greater stealth and precision with minimal risk to the individual."[19]

Army Special Operations Forces Vision 2010 outlines the U.S. Army Special Operations Command (USASOC) vision of future ARSOF operations and capabilities. Well-rooted in the operational concepts contained in *JV 2010* and *Army Vision 2010*, *ARSOF 2010* describes the vital role precision engagement systems will play in future ARSOF operations. In this document, USASOC highlights the importance of real-time information sharing among SOF and conventional forces with regard to precision target detection, identification, and engagement.[20]

Air Force Special Operations Forces 2025 contains the modernization requirements for AFSOC weapons systems, including AC-130 gunships. *AFSOF 2025* articulates the primary focus of future AFSOF precision engagement modernization efforts as the ability to provide discriminate weapons effects in support of SOF ground troops operating in urban environments. It goes on to state that such support should include both lethal and nonlethal effects.[21] *AFSOF 2025* also highlights the required capabilities that future AFSOF precision engagement systems must provide: selective target identification capability; enhanced adverse weather capabilities; enhanced stand-off distance and weapons accuracy; nonlethal weapons options; and improved capability to operate in urban environments.[22]

Precision Engagement Warfighting Concepts

As indicated in the various publications described in the previous section, future precision engagement platforms such as the AC-130 gunship will have a number of

warfighting roles during future military conflicts. Detailed analysis of these works indicates three central activities which will comprise future precision engagement operations: precision battlefield targeting, coordinated attacks on enemy targets, and the application of precision force on enemy targets. Figure 2 offers a comparison of JCS, service, and SOF perspectives on future precision engagement operations along these central themes.

Precision Engagement Mission Requirements

As indicated in the previous section, future precision engagement operations will feature three central activities: precision battlefield targeting, coordinated attacks on enemy targets, and the application of precision force on enemy targets. Based on these themes and the various JCS, service, and SOF vision publications described in the previous section, the *JV 2010* concept of precision engagement is therefore comprised of three essential mission requirements:

1. The ability to rapidly and precisely locate, identify, track, engage, and assess enemy targets across the spectrum of potential warfighting environments. This capability includes the requirement to employ very high resolution target detection sensors from long range using extremely accurate position information. It also includes the requirement to employ these targeting sensors in urban environments and all weather conditions.

2. The ability to integrate operations and firepower with other land, naval, air, and special operations forces. This capability includes the requirement to conduct real-time intelligence, data, and imagery transfer between target detection systems, weapons employment platforms, and surface combat forces. It includes the requirement to operate

CFJO	Army	Navy/ Marine Corps	Air Force	SOF
WARFIGHTING ROLE OF PRECISION ENGAGEMENT SYSTEMS				
• Apply desired effects across the range of operations	• Shape the battlespace for land-based forces	• Enable projection of ground forces ashore	• Apply selective force against specific targets	• Aid in the execution of SOF missions and tasks
PRECISION TARGETING CONCEPTS				
• Rapid, precise target detection & identification • Precision battle damage assessment	• Precise target detection, identification, and tracking	• Perform "smart targeting"	• Locate enemy targets with precision	• Selective identification & tracking of high priority targets
COORDINATED ATTACK CONCEPTS				
• Real-time sensor-to-shooter links	• Real-time intelligence/data transfer via sensor-to-shooter links • Concurrent combined arms employment	• Integration of firepower with naval and ground forces • Real-time links between target detection and weapons delivery systems • Minimum collateral damage and fratricide	• Superior situational awareness • Minimum collateral damage and fratricide	• Real-time data sharing between conventional and SOF forces
PRECISION FORCE CONCEPTS				
• Precision ordnance delivered from long ranges • Lethal & non-lethal munitions options • Minimum collateral damage • Rapid reengagement if required	• Increased accuracy and lethality from extended ranges • Employment of lethal and nonlethal munitions	• Precision all-weather lethal and nonlethal ordnance delivered from extended ranges	• Ability to attack any facet of enemy power • Precision employment of lethal and non-lethal munitions	• Enhanced weapons employment range and accuracy • Enhanced adverse weather and urban environment capabilities • Discriminate lethal and non-lethal effects

Figure 2. Comparison of Precision Engagement Concepts

and employ firepower concurrently with other combined arms assets, and the need to employ situation awareness systems and measures which will minimize, if not eliminate the possibility of fratricide against friendly forces.

3. The ability to apply selective, discriminate force on enemy forces and targets based on the battlefield situation. This capability includes the requirement for precision fire control systems capable of accurately delivering weapons from extreme long range. It also includes the requirement to employ high precision, all-weather capable, lethal and nonlethal ordnance against all forms of enemy forces and targets. This capability also requires the ability to employ selective weapons and fire support coordination measures which will prevent or minimize collateral damage to friendly and noncombatant forces, material, and property.

Figure 3 illustrates a hierarchy of precision engagement requirements derived from the precision engagement concepts presented in this section.

Precision Engagement Mission Tasks

Chairman of the Joint Chiefs of Staff Manual (CJCSM) 3500.04, *Universal Joint Task List*, contains a comprehensive hierarchical listing of the tasks performed by DOD forces during joint military operations. Currently undergoing its fourth revision, this manual is designed to aid military commanders in analyzing their mission requirements and tasks. Among it many uses, the *UJTL* serves as a common reference for DOD personnel developing the material systems needed to perform these warfighting tasks. The *UJTL* also contains a common set of physical, military, and civil conditions used to describe the operational contexts in which these mission tasks are to be performed.[23] By examining

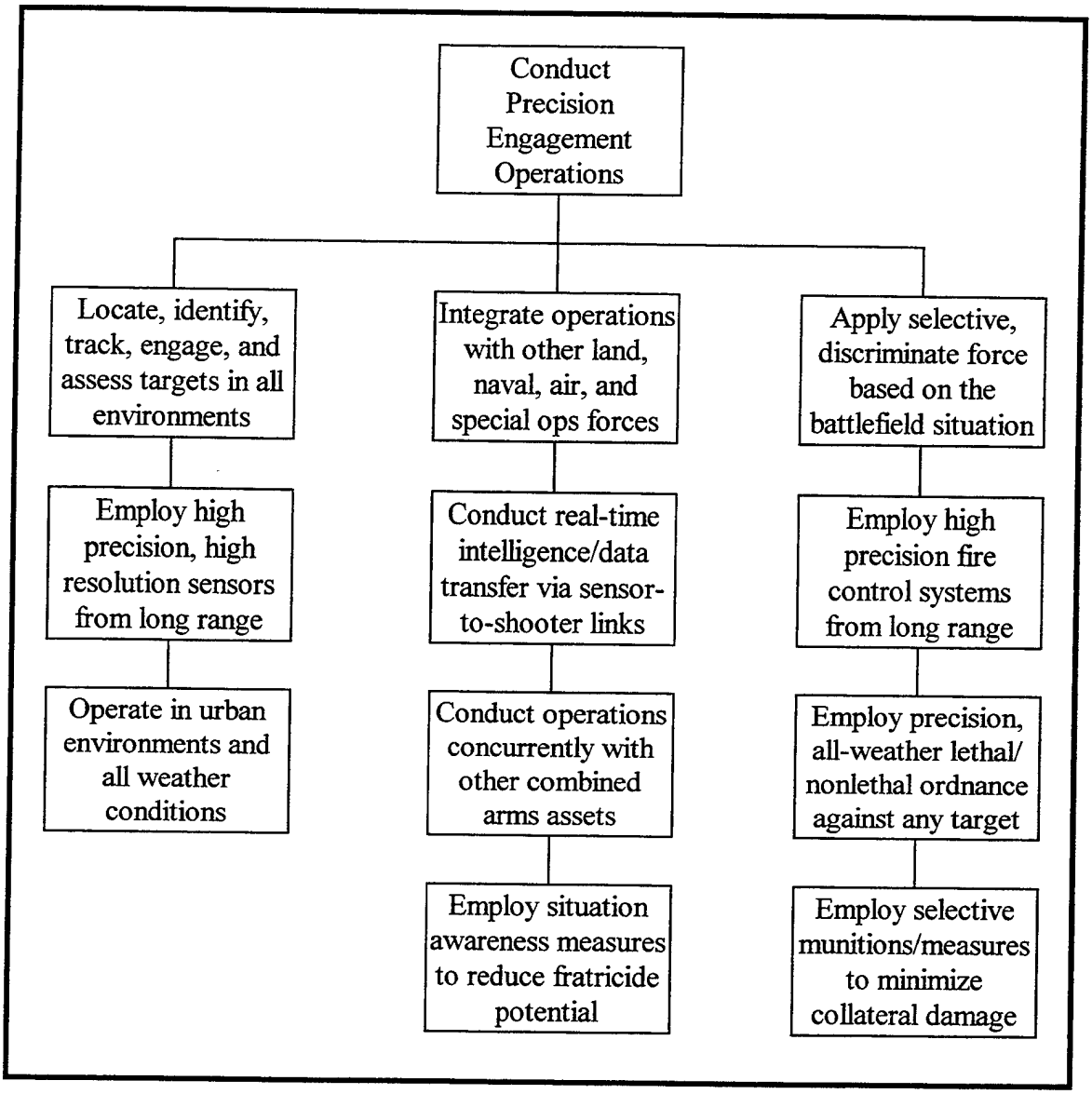

Figure 3. Hierarchy of Precision Engagement Requirements

current *UJTL* tasks in light of the precision engagement concepts and requirements developed in previous sections, specific precision engagement-related mission tasks can be developed. These tasks will subsequently form the basis for assessing the material technologies needed to conduct precision engagement operations in the next century.

The *UJTL* aligns warfighting tasks to one of three levels of war: strategic, operational, and tactical. At the strategic level of war, a nation or group of nations determines their national or multinational security objectives and guidance, then develops and uses national resources to achieve these objectives. At the operational level of war, campaigns and major operations are planned, conducted, and sustained to accomplish military objectives within a theater or area of operations. Based on JCS and service vision publications, the operational level of war is where precision engagement concepts will begin to significantly influence the conduct of future warfare. At the tactical level of war, individual battles and engagements are planned and executed to accomplish military objectives assigned to tactical units or task forces. Activities at this level focus on the arrangement and maneuver of combat forces in relation to one another and the enemy.[24] It is this level of war where precision engagement systems will be predominantly employed.

The *UJTL* describes military tasks assigned at the strategic and operational levels of war, leaving the development of tactical-level tasks to the services and unified combatant commands. Though limited to the strategic and operational levels of war, the *UJTL* provides an excellent starting point for determining tactical-level precision engagement-related mission tasks.

One of the six core operational-level tasks contained in the *UJTL* is termed "employ operational firepower." The *UJTL* describes this task as "to employ lethal and nonlethal means to defeat enemy forces or to maintain freedom of movement. Operational firepower is by its nature, primarily a joint/multinational task. Firepower refers to the delivery of all types of ordnance . . . as well as other nonlethal means against enemy

targets at operational depths."[25] By adapting this and other *UJTL* definitions of operational-level mission tasks in light of the precision engagement requirements indicated in the previous section, the tactical-level task employ precision tactical firepower can be further developed. Figure 4 illustrates the tactical-level mission tasks derived from the *UJTL* and the precision engagement requirements presented in the previous section. Subsequent sections explain these mission tasks, which are underlined for clarity and to facilitate reference to figure 4.

Tactical Task: Employ Precision Tactical Firepower

Based upon its operational-level parent task in the *UJTL*, the tactical task employ precision tactical firepower is defined as: To apply selective, discriminate force to defeat enemy forces or to maintain friendly freedom of movement based on the battlefield situation. Employing precision tactical firepower is by its nature a joint task involving integrated operations with joint/multinational land, naval, air, and special operations forces. Tactical firepower refers to the delivery of all forms of lethal and nonlethal means directed against tactical enemy targets.[26]

As illustrated in figure 4, this tactical-level task includes three subordinate subtasks. Based upon similar operational-level *UJTL* tasks and the precision engagement concepts and requirements indicated in previous sections, the definitions of these subtasks and their subordinate activities can be developed.

First Subtask: Conduct Precision Battlefield Targeting

The first major subtask associated with precision tactical firepower operations is conduct precision battlefield targeting, which is defined as: To positively identify and

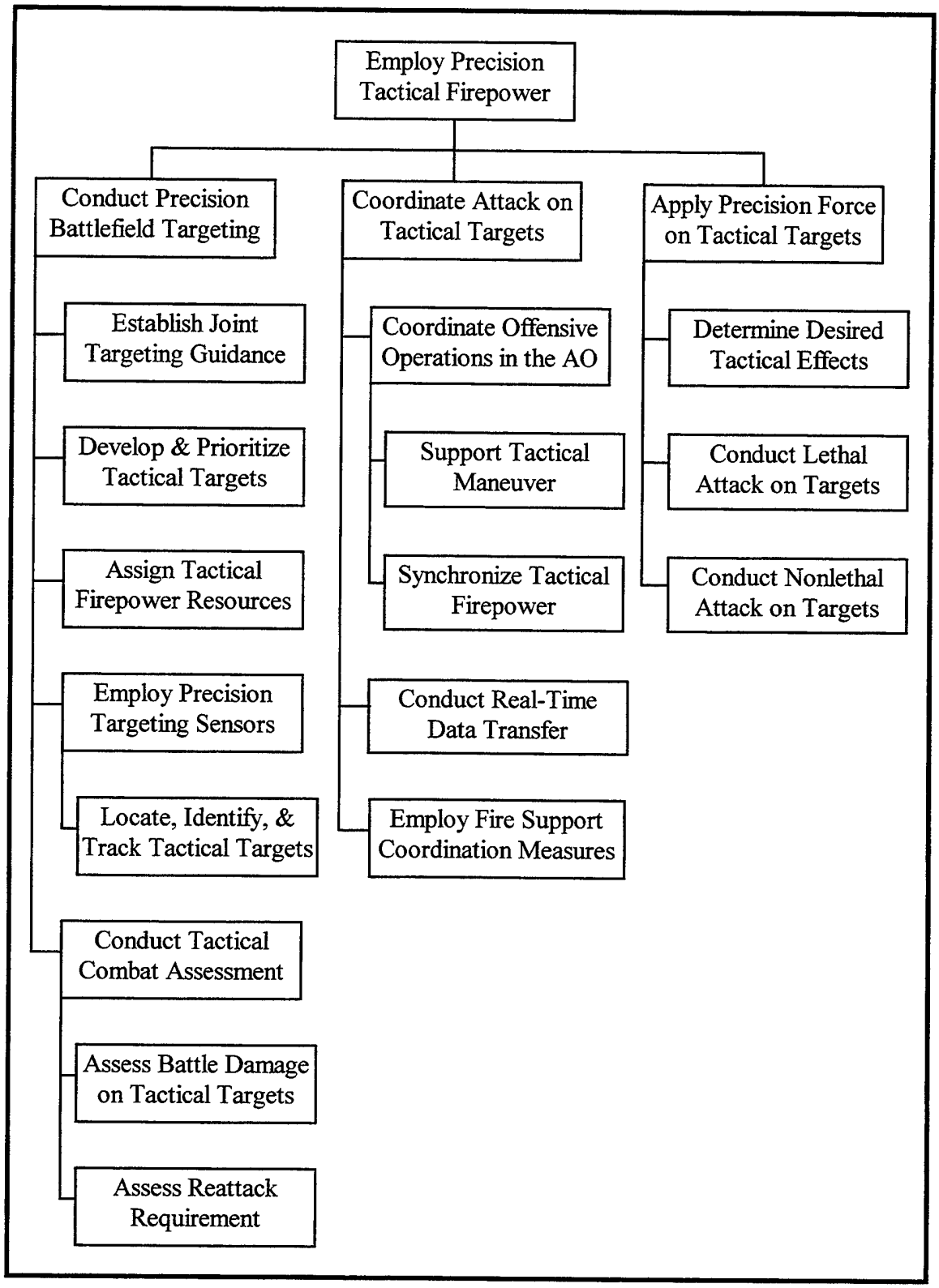

Figure 4. Hierarchy of Precision Engagement Tactical-Level Tasks

select land, sea, air, and space targets that decisively impact battles and engagements and to match these targets to appropriate joint or multinational precision engagement systems. Precision targeting is focused on attaining the tactical objectives and achieving the desired battlefield effects directed by supported joint force commanders. The term target is used in a broad sense and includes traditional military targets as well as those inherent to MOOTW.[27]

A number of essential subordinate activities fall under this subtask. First among these activities is establish joint targeting guidance, which is defined as: To determine the supported commander's targeting guidance and priorities. This guidance and prioritization conforms to overall battlefield tactical plans and objectives and uses inputs from intelligence and operations personnel to identify potential enemy targets for attack. This task includes determining the necessary target acquisition and identification assets and procedures to be employed for each identified target.[28]

The second subordinate activity under this subtask, develop and prioritize tactical targets, is defined as: To evaluate and choose tactical targets for attack in order to achieve the desired battlefield effects on enemy decisive points and centers of gravity consistent with the supported tactical level commander's intent. This task includes rank ordering high-payoff and high-value targets in order of importance and selecting the attack sequence needed to achieve desired battlefield outcomes.[29]

The third subordinate activity, assign tactical firepower resources, is defined as: To assign firepower assets and means to tactical targets consistent with the supported commander's plan and intent. This task includes determining and designating available

joint/multinational land, sea, air, and SOF firepower assets for each selected target or geographic target area for a given period of time.[30]

The fourth subordinate activity, employ precision targeting sensors, is defined as: To employ high accuracy, high resolution targeting sensors capable of detecting, locating, identifying, and tracking all forms of tactical targets across the spectrum of battlefield environments and conditions. This task includes performing these functions from long stand-off ranges and in all forms of ambient weather conditions. The term target includes traditional military targets as well as those inherent to MOOTW. This task applies to all battlefield environments ranging from barren desert to snow-covered arctic and includes highly congested urban terrain.

Subordinate to this fourth activity is locate, identify, and track tactical targets, which is defined as: To analyze each detected target and determine if, when, and how it should be attacked. This task includes comparing sensor imagery and data to planned targeting criteria, verifying target location and identity, computing moving target intercept points as necessary, reviewing applicable rules of engagement, determining ordnance aiming points, forwarding target and aimpoint data to appropriate weapons delivery assets, and designating and tracking tactical targets to be attacked.

The fifth subordinate activity under the precision battlefield targeting subtask, conduct tactical combat assessment, is defined as: To determine the overall effectiveness of joint/multinational force employment in tactical areas of operation as it relates to planned tactical and/or operational objectives.[31]

Two requirements are subordinate to this activity. The first, assess battle damage on tactical targets, is defined as: To conduct timely and accurate estimate of damage or effects resulting from the application of lethal or nonlethal force against tactical targets or objectives. Battle damage assessment (BDA) can apply to all forms of tactical targets throughout the range of military operations. BDA is primarily an intelligence responsibility with inputs from operators, and therefore requires timely and accurate transmittal of BDA imagery and data to intelligence personnel.[32]

The second requirement in this area, assess reattack requirement, is defined as: To evaluate the tactical effects from lethal or nonlethal attack on a target to determine if more, or more effective force is required to achieve the desired battlefield effect(s). This task includes evaluating the overall impact and effectiveness of such force against enemy targets and what, if any, changes or additional efforts are needed to meet the supported commander's tactical objectives.[33]

Second Subtask: Coordinate Attack on Tactical Targets

The second major subtask associated with precision tactical firepower operations is coordinate attack on tactical targets. This task is defined as: To coordinate engagement of tactical level targets and to shape and control the tempo of battles and engagements using all available joint and multinational tactical firepower assets against land, maritime, and airborne targets having tactical significance. The term target is used in a broad sense and includes traditional military targets as well as those inherent to MOOTW.[34]

This subtask includes three major subordinate activities, the first of which, coordinate offensive operations in the area of operations (AO), is defined as:

> To coordinate tactical offensive operations (offensive counterair (OCA); suppression of enemy air defenses (SEAD); interdiction of tactical forces/targets; close air support; show of force; demonstration; forcible entry; reinforce/expand lodgment; raids; penetration, direct assault, and turning movements; direct action; all elements of information operations; psychological operations; electronic attack; antisubmarine, surface and subsurface warfare; and unconventional warfare) to achieve a position of advantage for the defeat or neutralization of enemy tactical forces in order to accomplish tactical or operational objectives. These operations, both lethal and nonlethal, are conducted in depth to support the concept of operations. This task involves taking the initiative from the enemy, gaining freedom of action, and massing effects to achieve tactical objectives. These operations are designed to delay, disrupt, destroy, or degrade enemy tactical forces or critical tasks and facilities and to affect the enemy's will to fight. This task includes conventional and special operations forces. Coordination includes integrating battlefield targeting and attack operations, as well as liaison requirements for aircraft providing direct close air support to surface forces.[35]

This activity includes two subordinate functions, the first of which, support tactical maneuver, is defined as: To support land and maritime joint tactical maneuver as part of the supported commander's concept of operations by engaging tactical land, sea, and airborne targets with available joint and multinational tactical firepower delivery systems.[36]

The second requirement under the activity, synchronize tactical firepower, is defined as: To integrate and synchronize tactical attacks on single or multiple tactical targets at decisive points and times. This task includes integrating lethal and/or nonlethal attacks, friendly command and control and electronic warfare measures, and efforts to minimize or eliminate adverse effects on friendly forces, neutral forces, and noncombatants.[37]

The second major activity in the area of coordinating attacks on tactical targets is conduct real-time data transfer, which is defined as: To transmit in near real time,

intelligence information, data, and imagery from and between tactical, operational, and strategic sources regarding tactical battlefield situation and status. This task includes sharing information regarding the nature and characteristics of tactical areas of operation and decisive points, friendly and enemy force tactical disposition, and the location, identity, status, and condition of tactical targets, including BDA.[38]

The third major activity, employ fire support coordination measures, is defined as: To develop and employ procedures associated with the command and control of joint and multinational fire support systems. Within their AOs, land and maritime commanders employ permissive and restrictive fire support coordination measures to enhance the attack of enemy targets, prevent fratricide of friendly and neutral forces and noncombatants, and protect critical infrastructure, facilities, and sites of religious or cultural significance. These fire support coordination measures conform to the supported commander's concept of operations and may set the stage for future operations.[39]

Third Subtask: Apply Precision Force on Tactical Targets

The third major subtask associated with precision tactical firepower operations is apply precision force on tactical targets. This task is defined as: To engage tactical land, sea, and air targets with available joint and multinational systems capable of delivering precision lethal and nonlethal ordnance or force. The objective of such attacks is to destroy, disrupt, degrade, delay, or impair enemy forces, the enemy's military potential (forces, facilities, critical nodes, lines of communication, networks, and infrastructure) before it can be used against friendly forces, and to affect the enemy's will to fight in tactical engagements.[40]

This subtask includes three subordinate activities, the first of which, determine desired tactical effects, is defined as: To determine the supported commander's desired tactical firepower effects (e.g., destroy, disrupt, degrade, delay, impair). These effects conform to overall battlefield tactical plans and objectives and use inputs from intelligence and operations personnel to identify enemy target vulnerabilities and susceptibility to precision force. This task includes determining the necessary ordnance or force to be employed on each target, the required time and place for attacks, and the employment procedures to be used. The effects of precision force support land and maritime joint tactical maneuver as part of the supported commander's concept of operations.

The second subordinate activity, conduct lethal attack on targets, is defined as: To attack tactical land, maritime, and airborne targets with available joint/ multinational lethal munitions designed to destroy, disrupt, degrade, or delay enemy tactical forces or targets and to affect the enemy's will and ability to fight. This task involves highly accurate fire control systems capable of delivering high precision, all-weather capable ordnance from long stand-off ranges.[41]

The third subordinate activity, conduct nonlethal attack on targets, is defined as: To engage tactical land, maritime, and airborne targets with available joint/multinational means designed to impair, disrupt, or delay the performance of enemy tactical forces, activities, and facilities. These means include the use of precision, all-weather nonlethal munitions, psychological operations (PSYOP), electronic warfare, certain SOF capabilities, and chemical contamination of enemy forces and equipment. Nonlethal

attacks may be especially prevalent in MOOTW, where the objective of such attacks may be to foster favorable attitudes toward the host nation or to modify insurgent behavior.[42]

Precision Engagement Employment Conditions

Per the *UJTL*, employment conditions are used during the mission analysis process to describe variables in the environment that affect task performance. Several conditions may apply to individual mission tasks depending on the battlefield situation and environment at hand.[43] Among their many uses, these *UJTL* conditions are highly relevant to the precision engagement implementation process in that they shape the performance requirements of materials and systems needed to perform precision engagement tasks. Subsequent paragraphs examine the relevance and relationship of *UJTL* conditions to the tactical-level precision engagement tasks described in the previous section.

In the *UJTL*, mission conditions are organized into three broad categories: physical, military, and civil environments. As illustrated in figure 5, a number of related conditions are organized under each of these three categories.

Physical Environment

Analysis of *UJTL* descriptions of physical environment factors indicates these conditions are likely to have great impact on the accomplishment of tactical-level precision engagement tasks due to the fact that many of these tasks are oriented on battlefield terrain. Physical environment conditions describe those mission influences arising from nature and modifications to the environment as created by man. These factors are grouped into four major subcategories: land, sea, air, and space conditions.[44] Of these four subcategories, land and air conditions will pose significant challenges to precision

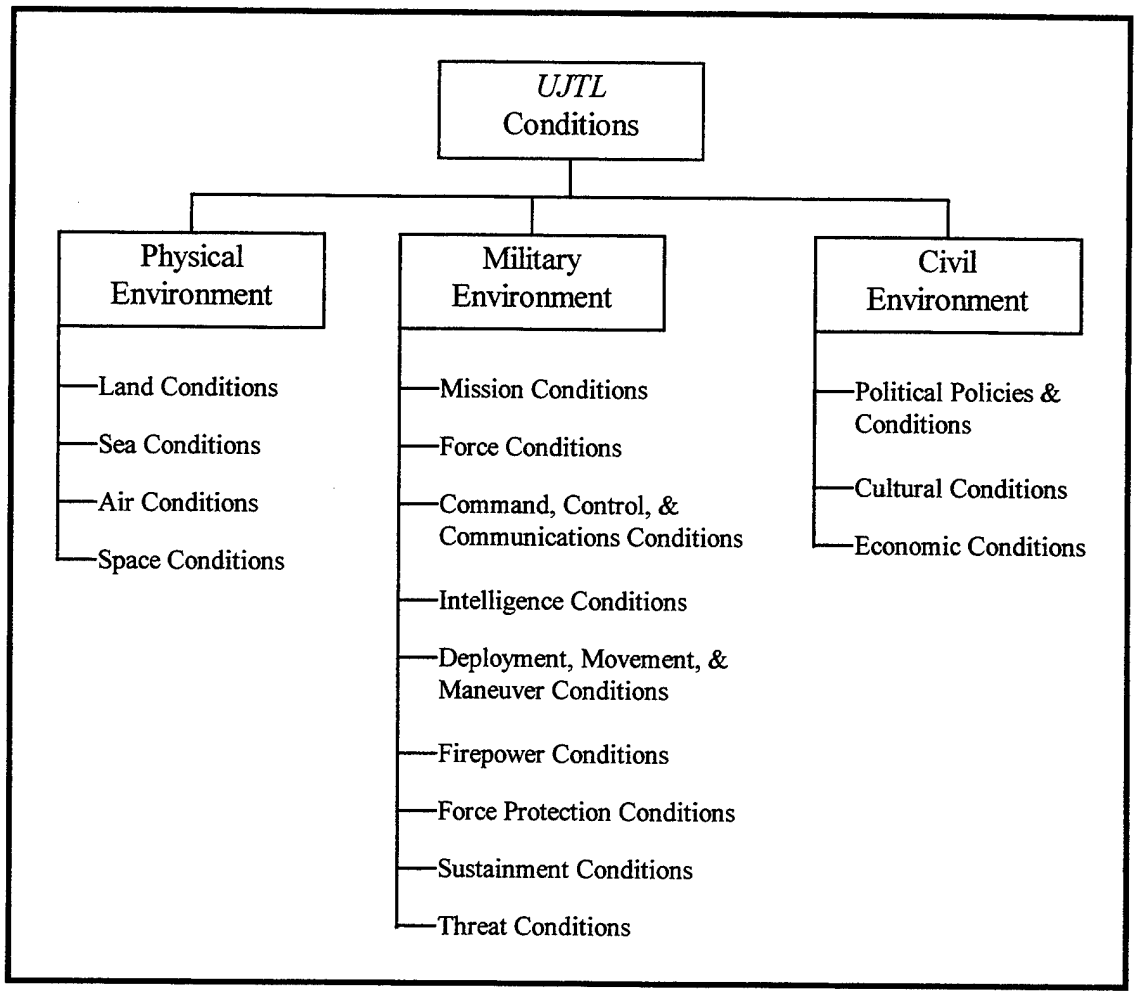

Figure 5. Hierarchy of *UJTL* Conditions

engagement task accomplishment. Land conditions, including the nature and characteristics of battlefield terrain, geological features, synthetic (manmade) terrain features, and landlocked waters will influence the ability to conduct precision battlefield targeting operations, support the tactical maneuver of surface combat forces, and assess the effectiveness of precision weapons. Atmospheric conditions related to climate, season, weather systems, and visibility in the area of operations may greatly affect the performance of precision targeting sensor systems and precision ordnance delivered by aircraft.

Military Environment

A number of *UJTL* conditions related to military environments will also influence tactical-level precision engagement task accomplishment. Conditions in this area encompass military forces and their ability to execute mission tasks.[45] First among all factors in this area, the very nature of military missions, including mission instructions, legal considerations, areas of operation, and available time will influence the accomplishment of virtually every precision engagement task. Second, the composition, capabilities, and battlefield disposition of military forces, both friendly and enemy, will likewise affect each precision engagement task. Third, the nature and capabilities of friendly command, control, and communications systems will likely impact the ability to coordinate and conduct precision attacks on enemy tactical targets. Fourth, the nature and characteristics of intelligence systems and information may greatly influence battlefield targeting tasks. Fifth, a number of firepower-related conditions will challenge the ability to perform battlefield targeting tasks and apply precision force on enemy targets. These conditions include the degree to which enemy targets are dispersed, camouflaged, hardened, and mobile, as well as the potential to cause collateral damage. Sixth, the nature and disposition of enemy threat systems will drive the requirement to conduct long-range targeting and weapons employment. Finally, no precision engagement task can be accomplished unless sustainment-related factors applicable to the maintenance and support of high-tech targeting sensors, communications equipment, and precision firepower systems are analyzed and considered.

Civil Environment

The third set of *UJTL* conditions under the civil environment category describe those factors related to people, their government, politics, culture, and economy as they apply to military operations.[46] Current political policies, cultural factors, and economic conditions incumbent to American, allied, and potential enemy governments may greatly affect the military strategies and decisions formulated by senior defense officials. Ultimately, the results of these decisions will influence the selection of tactical targets and the amount of force applied upon them.

The myriad of mission employment conditions described above will pose a number of challenges to the accomplishment of the tactical-level precision engagement tasks. In wartime, these conditions will set the stage for precision engagement combat operations. In peacetime, these conditions will influence the design and performance of precision engagement technologies and material systems needed to conduct such operations.

Precision Engagement Material Technologies

Achieving *JV 2010*'s new operational concepts will, in large measure, depend on the DOD's ability to develop, mature, and field advanced technologies and material systems beyond those which presently exist in the armed forces. Toward this end, the *Joint Warfighting Science and Technology Plan* and the *Defense Technology Area Plan*, both published in January 1997 by the DOD's Director of Defense Research and Engineering, offer insight into the nature of advanced technologies and material systems needed to conduct future precision engagement operations.

Joint Warfighting Capability Objectives

The purpose of the *JWSTP* is to provide a unified focus for DOD research and development activities in accordance with the new warfighting principles outlined in *JV 2010*. Its objective is to ensure that DOD science and technology (S&T) programs support and deliver the joint warfighting capabilities needed to conduct twenty-first century military operations.[47] Toward this end, the *JWSTP* contains and describes ten Joint Warfighting Capability Objectives (JWCOs) which serve to focus DOD S&T activities. Based on *JWSTP* descriptions of these mission areas, three of these ten JWCO areas support the tactical-level precision engagement tasks described in earlier sections of this chapter. These three JWCO mission areas are:

1. Precision Force
2. Combat Identification
3. Military Operations in Urban Terrain (MOUT)[48]

Subsequent paragraphs describe the technology objectives for material systems needed in these mission areas.

Precision Force

Per the *JWSTP*, precision force is defined as "the capability to destroy selected high-value and time-critical targets, or to inflict damage with precision while limiting collateral damage. Precision force consists of three elements: target acquisition, command and control to provide a capability to bring fire to bear on targets, and precision munitions to produce desired target effects."[49] According to the *JWSTP*, the precision force mission area requires technological advances in a number of areas, including

targeting sensors, command, control, and battle management systems, highly interoperable "sensor-to-shooter" systems, and enhanced munitions which provide increased weapon employment range, accuracy, lethality, and effectiveness. As stated in the *JWSTP*, a key element of future precision engagement operations will be the employment of "hunter/standoff killer" (HSOK) systems and weapons.[50]

Per the *JWSTP*, future precision force material systems should offer the following capabilities:

1. Real-time, fused pictures of the battlespace, with integrated decision aids/tools embedded within.

2. Linkages that enable rapid target search and acquisition, near real-time battlefield coordination and target selection, and handoff of time-critical targets to weapons delivery platforms. Direct sensor-to-shooter taskings should take place in less than one minute and include simultaneous tasking of required electronic warfare support elements needed to suppress or defeat enemy defenses in the proposed target area.

3. Near real-time ability to determine the physical effects of force applied to targets and assess the impact of this force on tactical operations.[51]

Combat Identification

As stated in the *JWSTP*, combat identification (CID) is "the process of attaining an accurate characterization of entities in a combatant's area of responsibility to the extent that high-confidence, real-time application of tactical options and weapon resources can occur. The objective of CID is to maximize combat/mission effectiveness while reducing total casualties (due to enemy action and fratricide)."[52] The primary objective of combat

identification technologies is to provide correlated battlefield imagery and data in ways that allow potential targets to be rapidly and positively identified as friendly, enemy, or neutral. Per the *JWSTP*, future combat identification systems must be capable of positively identifying every potential target throughout the battlefield as a necessary precursor to weapons employment.

As indicated in the *JWSTP*, two classes of advanced material solutions are required to fulfill CID capability objectives: target acquisition and identification sensor systems, and command, control, and communications systems, specifically radio and digital datalink systems.[53] According to the *JWSTP*, future precision engagement systems must have the ability to combine onboard data from multiple targeting sensors with battlefield data supplied from offboard sources. Furthermore, future CID systems will feature the use of automatic target recognition (ATR) technologies that will enable near perfect target identification. The goal of ATR technologies is provide rapid and reliable detection, geolocation (position), tracking, identification, and prioritization of targets so that human operators and decision makers can make weapons employment decisions with high degrees of confidence.[54]

Per the *JWSTP*, future combat identification systems should incorporate the following capabilities:

1. Robust, high-confidence target identification capability at standoff ranges commensurate with weapons employment ranges and lethality.

2. Automated target position reporting and correlation cues to battlespace situation awareness systems.

3. Interoperable, secure, nonexploitable digital datalink capabilities.

4. Measures which minimize the possibility of friendly casualties due to enemy action or fratricide.[55]

Military Operations in Urban Terrain

The *JWSTP* defines military operations in urban terrain (MOUT) as "the capability to operate and conduct operations in built-up areas and to achieve military objectives with minimum casualties and collateral damage. MOUT includes nonlethal weapons, precise [lethal] weapons, surveillance, and situation awareness via communications [systems] effective in urban areas."[56] Per the *JWSTP*, MOUT is not so much a unique warfighting capability as an environment in which the *JV 2010* operational concepts, including precision engagement, will be tested under the most demanding conditions. Advanced technologies needed for MOUT operations will be unique due to the complex, resource-intensive nature of military conflicts in this environment.[57]

As indicated in the *JWSTP*, two critical areas of emphasis are applicable to precision engagement operations: situation awareness and weapons effectiveness. Per the *JWSTP*, robust, high accuracy situation awareness systems will be vital to conducting offensive combat operations in urban terrain. Given the complexities of MOUT environments, gaining perfect knowledge of friendly and enemy positions and their combat intentions will pose the most significant challenge to future precision engagement operations in urban environments. With regard to weapons effectiveness, the *JWSTP* states that advanced weapons are needed in order to properly balance lethality against the targets expected to be encountered in MOUT scenarios. In addition to current U.S.

capabilities in the area of precision-guided lethal weapons, the *JWSTP* calls for enhanced accuracy, all-weather, night-capable lethal and nonlethal munitions which can provide a graduated, selective response to MOUT situations while minimizing the potential for collateral damage fratricide among friendly and noncombatant forces.[58]

Per the *JWSTP*, future precision engagement systems should provide the following capabilities in order to conduct combat operations in MOUT environments:

1. The ability to accurately locate friendly and enemy forces with complete knowledge of the environment.

2. Enhanced target acquisition and identification capabilities, including the ability to differentiate friend from foe in reduced/no visibility situations and the ability to target snipers and mortars.

3. Near real-time sensor-to-shooter engagement time.

4. Enhanced weapons and munitions capable of employment day or night, in all weather conditions, and from long stand-off ranges. These improved weapons must offer a measured response capability, improved effectiveness against fortified or dug-in targets, the ability to control individuals, crowds, and vehicles with nonlethal force, and minimize the susceptibility of individual combatants and noncombatants to fratricide and collateral damage.[59]

Defense Technology Objectives

The purpose of the *DTAP* is to document the content and principal objectives of DOD S&T efforts in a given technology area in support of the *JWSTP*. Unlike the *JWSTP* which categorizes S&T objectives according to mission areas (JWCOs), the *DTAP*

presents S&T objectives categorized by technology area.[60] The *DTAP* describes defense technology objectives (DTOs) in ten technology areas, two of which support the tactical-level precision engagement tasks described in previous sections of this chapter. These two technology areas are:

1. Sensors, Electronics, and Battlespace Environment
2. Weapons

Subsequent paragraphs describe the technology objectives which relate to the precision engagement capability objectives identified in the previous section.

Sensors, Electronics, and Battlespace Environment

The sensors, electronics, and battlespace environment (SE&BE) portion of the *DTAP* identifies technology objectives that support the *JWSTP* precision force, combat identification, and MOUT mission areas. The SE&BE technology area focuses on material systems needed to locate, identify, and track enemy land, sea, air, and space-based targets across the spectrum of military conflict and potential warfighting environments.[61] Three of the fourteen technology areas described in the SE&BE portion of the *DTAP* relate to the tactical-level precision engagement tasks discussed in previous sections of this chapter: radar sensor systems, electro-optic sensor systems, and automatic target recognition systems.

Radar Sensor Systems

The SE&BE section of the *DTAP* indicates that advanced radar sensor systems are needed in order to fulfill *JWSTP* requirements related to precision force, combat identification, and MOUT operations. In these mission scenarios, advanced radar sensors

are to provide the capability for long-range, all-weather detection, location, and identification of battlefield targets. According to the *DTAP*, advanced radar sensor development programs should primarily focus on capabilities which allow precision engagement platforms to detect, recognize, and classify a broad spectrum of battlefield targets from extreme stand-off ranges. The *DTAP* indicates three top-level performance goals for advanced radar sensor systems:

1. The ability to detect, identify, and track low radar cross section (RCS) targets located in difficult operating environments, e.g., targets embedded among extensive ground clutter (MOUT environments) or concealed by foliage or camouflage.

2. The ability to provide enhanced resolution, two-dimensional radar images in the near-term, with high resolution, three-dimensional images the goal for the long-term.

3. The ability to control and direct all-weather, precision-guided lethal and nonlethal munitions.[62]

Electro-Optic Sensor Systems

Like their radar brethren, advanced electro-optic (EO) sensor systems are needed to support *JWSTP* capability objectives in the precision force, combat identification, and MOUT mission areas. Per the *DTAP*, high-resolution, multi-spectrum EO sensor systems are required in order to detect, identify, track, and deliver precision ordnance against a wide variety of battlefield targets.[63] The *DTAP* indicates several technology objectives related to advanced EO sensor systems:

1. Multifunction sensor suites capable of fusing sensor imagery from multiple on-board and off-board sources. This sensor suite should provide the ability to conduct

extreme long-range target acquisition and identification, determine target locations with a high degree of accuracy, support simultaneous tracking and engagement of multiple targets, simultaneously guide multiple precision weapons, and permit detailed battle damage assessment.

2. Passive (non-emitting) EO sensors which provide high resolution imagery and the ability to conduct long-range detection, identification, and tracking of targets.

3. Active (laser-based) EO sensors capable of identifying, classifying, tracking, designating, and employing precision-guided ordnance onto enemy targets.[64]

Automatic Target Recognition

The third and final SE&BE technology area related to precision engagement operations is automatic target recognition. As described in the *DTAP*, advanced ATR technologies will be the key enabler for advanced radar and EO sensor systems. Per the *DTAP*, ATR models, databases, and mathematical algorithms should be developed and integrated with targeting sensor systems in order to support beyond visual range (BVR) acquisition, recognition, and engagement of battlefield targets. Additionally, ATR technologies should facilitate real-time sensor-to-shooter operations, precision targeting in MOUT environments, and reduce the potential for collateral damage and fratricide to friendly and noncombatant forces.[65]

Weapons

The weapons portion of the *DTAP* includes technology objectives that support *JWSTP* requirements in the precision force mission area. This technology area describes S&T efforts related to conventional (nonnuclear) weapons designed to enable precision

engagement platforms to more effectively destroy or incapacitate enemy personnel, materiel, infrastructure, and threat systems. Two of the three technology areas in this portion of the *DTAP* directly relate to the tactical-level precision engagement tasks identified in previous sections of this chapter: conventional weapons and directed energy weapons.[66]

Conventional Weapons

The conventional weapons portion of the *DTAP* specifically identifies two key technology areas applicable to AC-130 gunships: guns and ordnance.[67] Per the *DTAP*, future advanced guns systems should offer the following capabilities:

1. Enhanced fire control algorithms which improve munitions employment accuracy.

2. Enhanced gun aiming and stabilization systems which improve munitions accuracy and reduce ordnance dispersion patterns along the ground.

3. Composite gun barrel technologies which support high energy munitions, higher rates of fire, and longer barrel life.

4. The potential to employ electrically-fired, hypervelocity munitions (also referred to as "rail guns").

5. The ability to fire precision nonlethal munitions.[68]

The *DTAP* identifies a number of key technology objectives for advanced conventional ordnance. Per the *DTAP*, advanced precision engagement platforms should be capable of delivering the following array of munitions:

1. Small-diameter, precision-guided munitions equipped with multi-spectrum, steerable seeker heads that enable single-shot kills.

2. Autonomous precision-guided munitions capable of automatically acquiring and homing in on enemy targets ("fire and forget" weapons).

3. Weapons with adaptable fuses and warheads which offer improved hard-target penetration and destruction capability, and resistance to enemy electronic countermeasures.

4. Anti-armor munitions which can defeat all forms of armored vehicles and equipment.

5. Adaptable "combined effects" munitions with enhanced lethality against both light and heavily armored systems and materiel.[69]

Directed Energy Weapons

As stated in the *DTAP*, directed energy weapons (DEW) offer the potential for a twenty-first century paradigm shift with regard to precision engagement operations and weapons employment. By the year 2010, emerging high-power laser and microwave technologies may completely revolutionize the methods by which enemy targets can be engaged and neutralized. DEW technologies currently under development are focused on providing the following capabilities:

1. Unconstrained, surgically accurate force, delivered from extreme long range at the speed of light and sound.

2. Selective, graduated force which offers the ability to deliver tailored nonlethal force designed to impair, delay, or disrupt enemy forces or targets, or lethal force

designed to destroy enemy personnel, equipment, materiel, information systems, threat systems, and infrastructure targets.

3. Multiple shots per single delivery platform.

4. Synergy with high-resolution radar and EO sensor systems.

5. Minimal collateral damage in urban/politically sensitive target environments.[70]

AC-130 Gunship Precision Engagement Material Requirements

Given the tactical-level precision engagement mission tasks derived from current JCS, service, and SOF vision publications, and the precision engagement-related technology objectives described in current DOD science and technology planning documents, the primary research question underlying this thesis can finally be answered. Based on analysis of these mission tasks and technologies objectives, the material systems needed to conduct future precision engagement operations can be grouped into three major categories: precision targeting sensor systems, battlefield coordination systems, and precision lethal and nonlethal weapons and munitions. Given these three categories of precision engagement systems, subsequent paragraphs describe the nature of material systems and capabilities which should be installed on the AC-130 gunship in order for this aircraft to provide effective, precision fire support in the 2010 timeframe.

Precision Targeting Sensor Systems

Precision targeting sensor systems primarily support the tactical-level subtask conduct precision battlefield targeting, but also have strong ties to the other subtasks comprising tactical precision engagement operations. In order to accomplish battlefield

targeting tasks, the AC-130 gunship should be equipped with the following precision targeting sensor systems and capabilities.

Multifunction Sensor Suite

The AC-130 gunship should have a robust, multifunction sensor suite consisting of advanced radar and EO sensor systems. This sensor suite should provide the ability to:

1. Conduct long-range target acquisition and identification commensurate with weapons delivery capabilities.

2. Determine the precise geolocation (position) of friendly and enemy forces and targets.

3. Fuse radar and EO sensor imagery from multiple on-board and off-board sources.

4. Simultaneously track and engage multiple targets with precision-guided munitions.

5. Permit detailed battle damage assessment.

The sensor suite should include automatic target recognition technologies which:

1. Enable advanced radar and EO sensor systems to acquire, identify, and engage enemy targets beyond visual range, in urban environments, and under conditions of limited visibility.

2. Facilitate real-time sensor-to-shooter activities.

3. Reduce the potential for collateral damage and fratricide among friendly and noncombatant forces.

Additionally, the sensor suite should provide the ability to determine the effects of precision weapons applied against enemy targets, thereby allowing operators and decision makers to assess the impact of precision strikes employed in support of tactical operations.

Radar Sensor Systems

As an element of the sensor suite, advanced radar sensors should provide the ability to detect, identify, and track low RCS targets (e.g., trucks, armored personnel carriers, artillery pieces) located in areas of extensive ground clutter or concealed by foliage or camouflage. Additionally, these radar sensors should provide high resolution two-dimensional and three-dimensional radar imagery in order to identify and engage tactical targets, and assess battle damage on tactical targets. Furthermore, radar sensors should provide the ability to employ all-weather, precision-guided lethal and nonlethal munitions against low RCS targets in urban environments and under conditions of restricted visibility.

Electro-Optic Sensor Systems

Advanced EO sensor systems should be installed on AC-130 gunships in order to conduct tactical precision engagement operations. Passive EO sensors should provide high quality, high resolution imagery of tactical targets and support the requirement to detect, identify, track, engage, and assess targets from long stand-off ranges. EO sensors should also include active laser components capable of supporting long-range target identification, tracking, and the employment of precision-guided ordnance.

Battlefield Coordination Systems

Battlefield coordination systems primarily support the tactical-level subtask coordinate attack on tactical targets by providing the critical links between battlefield targeting and weapons delivery systems. As indicated in current JCS, service, and SOF doctrine, future precision engagement operations will involve concurrent employment of joint and multinational combined arms assets and feature the use of hunter/standoff killer teams. In order for the AC-130 gunship to effectively operate in these mission scenarios, it should be equipped with the real-time sensor-to-shooter capabilities described below.

Real-Time Sensor-To-Shooter Links

Real-time sensor-to-shooter links should provide the ability to quickly acquire, identify, and coordinate attacks on enemy targets. They should provide the ability to transmit and receive fused sensor imagery and information related to tactical operations in the area of operation. These links should enable other ground and naval forces, airborne platforms, and decision makers to rapidly coordinate and hand off time-critical targets to the gunship. These systems must be interoperable with joint and multinational forces operating in the battlespace. They should guarantee secure, nonexploitable transfer of battlefield information, data, and sensor/BDA imagery. Sensor-to-shooter links should also provide the ability to transfer real-time fire support coordination information and measures between the aircraft, ground forces, and other weapons delivery platforms in order to minimize the possibility of fratricide among friendly and noncombatant forces.

Precision Lethal and Nonlethal Weapons and Munitions

In order to accomplish the tactical-level subtask apply precision force on tactical targets, AC-130 gunships will require advanced precision lethal and nonlethal weapons and munitions as described below.

Conventional Weapons

The AC-130 gunship should be outfitted with advanced conventional armament and munitions capable of applying a wide range of precision force on enemy targets. Enhanced fire control algorithms and gun aiming and stabilization systems should be developed and installed in order to improve gunfire accuracy and reduce munition dispersion patterns along the ground. Improved gun systems incorporating composite materials should be installed, thereby enabling high rates of fire and permitting the employment of lethal and nonlethal munitions launched via high energy conventional propellants or electromotive force. The AC-130 should be capable of delivering a wide array of conventional lethal and nonlethal munitions, including:

1. Small-diameter, precision-guided munitions equipped with multi-spectrum, steerable seeker heads that enable single-shot kills.

2. Autonomous precision-guided munitions capable of automatically acquiring and homing in on enemy targets.

3. Weapons with adaptable fuses and warheads which offer improved hard-target penetration capabilities, enhanced lethality against fortified and dug-in targets, and resistance to enemy electronic countermeasures.

4. Anti-armor munitions which can defeat all forms of armored vehicles and equipment.

5. Adaptable "combined effects" munitions with enhanced lethality against both light and heavily armored systems and materiel.

6. Selective nonlethal weapons or other means by which nonlethal force can be directed against individuals, crowds, and vehicles located in urban environments.

Directed Energy Weapons

As indicated in current DOD science and technology planning documents, the requirement to deliver selective, discriminate lethal and nonlethal force in support of MOOTW appears to be the most challenging material requirement needed to support twenty-first century precision engagement operations. The DOD considers directed energy weapons to be a long-term material solution to this requirement. Therefore, once these technologies mature, the AC-130 gunship should be considered a viable candidate for incorporation of directed energy weapons.

Summary

Based upon current national military strategy, *JV 2010*, the *CFJO*, and the service and SOF vision publications described in this chapter, precision engagement platforms like the AC-130 gunship will play vital roles in twenty-first century warfare. The tactical-level mission tasks derived from these publications indicate the capabilities that future precision engagement platforms will have to provide in support of future military operations. In order to perform these future warfighting tasks, advanced material systems and capabilities beyond those which presently exist in the DOD are required. As indicated in the *JWSTP*

and the *DTAP*, the DOD S&T community is aggressively pursuing advanced material systems needed to fulfill these requirements. Given the fact AC-130 gunships will continue to support military operations across the spectrum of conflict well into the next century, the material systems and capabilities identified in this chapter offer potential solutions which would enable the AC-130 to provide effective, precision firepower in support of twenty-first century precision engagement operations.

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CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Introduction

The purpose of this chapter is four-fold: first, to identify conclusions regarding *Joint Vision 2010* and its relevance to the future of warfare; second, to offer recommendations for implementing *JV 2010*'s new operational concepts within SOF doctrine and weapon system planning documents; third, to recommend possible courses of action by which the precision engagement capabilities indicated in chapter 4 might be implemented on AC-130 gunships; and finally, to present topics for follow-on research related to this thesis.

Conclusions

During the course of research performed in support of this thesis, several important conclusions regarding twenty-first century warfighting concepts and requirements surfaced. First among these is the conclusion that *JV 2010* and the Joint Warfighting Center's *Concept for Future Joint Operations* offer exceptional insight into the nature of future joint warfare and the role of military forces in support of national security strategy. Taken together, these two documents provide a strong intellectual foundation for implementing the military capabilities needed to achieve twenty-first century national security objectives. For the foreseeable future, *JV 2010* and the *CFJO* will undoubtedly remain the capstone guidelines by which the armed forces will develop future employment doctrine and the advanced material systems needed to conduct future joint warfare.

Second, America's armed forces are fully embracing *JV 2010*'s new warfighting concepts. *JV 2010*, the *CFJO*, and the service's long-range vision publications have spawned a number of recent and on-going research efforts which further articulate the new warfighting concepts outlined in *JV 2010* and the means by which they might be achieved. This trend will undoubtedly continue in the near future.

Finally, numerous research efforts underscoring *JV 2010* have identified many advanced technologies and material systems needed to fulfill *JV 2010*'s futuristic warfighting concepts. Given *JV 2010*'s considerable emphasis in current DOD science and technology planning documents, the guidelines for developing and fielding the advanced material technologies needed to conduct twenty-first century warfare will undoubtedly mature rapidly.

Recommendations

As a result of the analyses conducted in support of this thesis, a number of recommendations for implementing *JV 2010*'s new operational concepts within USSOCOM and the AFSOC have surfaced. These recommendations are:

1. AFSOC should consider producing a twenty-first century vision statement similar to the U.S. Army Special Operations Command's *Army Special Operations Forces 2010.*

2. USSOCOM should develop a *Special Operations Forces Task List* based on Chairman of the Joint Chiefs of Staff Manual 3500.04B, *Universal Joint Task List.* This doctrinal manual should be congruent with similar manuals currently under development within the conventional military departments.

3. AFSOC should develop weapon system-specific Mission Essential Task Lists (METLs) based on the *UJTL*, the SOF task list indicated above, and AFDD 1-01, *Air Force Task List* (*AFTL*), which is currently under development at the Air Force Doctrine Center (AFDC).

4. AFSOC should include a discussion of the new warfighting concepts identified in *JV 2010* and the *CFJO* in the forthcoming revision of AFDD 2-7, *Special Operations*. Similarly, AFSOC should include SOF-unique concerns in the numerous other AFDDs currently under development at the AFDC.

5. AFSOC could further enhance their long-range planning document *Air Force Special Operations Force 2025* by including additional discussion on the future warfighting concepts described in *JV 2010*, the *CFJO*, conventional service vision statements, and the extensive body of *JV 2010*-related research projects and concept papers presently available from DOD libraries and on-line sources.

6. During the course of their next revision to *AFSOF 2025*, AFSOC should consider incorporating *UJTL* and *AFTL* mission tasks into their modernization planning process.

7. In their next revision of *AFSOF 2025*, AFSOC should consider incorporating the precision engagement-related mission tasks defined in chapter 4 of this thesis in the Precision Engagement/Strike Mission Area Plan.

8. In the next revision of their *Weapon System Roadmap*, AFSOC should consider incorporating appropriate Joint Warfighting Capability Objectives and Defense Technology Objectives contained (respectively) in the *Joint Warfighting Science and*

Technology Plan and the *Defense Technology Area Plan* as potential solutions to the material needs resulting from the modernization planning process. Additionally, AFSOC should consider incorporating the precision engagement-related technology objectives indicated in chapter 4 of this thesis in appropriate *Roadmap* sections related to AC-130 gunships.

9. AFSOC should consider developing and implementing an education and training program for SOF personnel featuring the new warfighting concepts contained in *JV 2010*, the *CFJO*, service and SOF vision publications, and *AFSOF 2025*. This program would be especially useful for AFSOC personnel involved in long-range planning, doctrine development, and material acquisition activities.

10. USSOCOM and AFSOC should sponsor additional *JV 2010*-related research efforts among students attending intermediate and senior service schools. These research efforts should focus on further defining the material requirements needed to conduct twenty-first century special operations missions.

Regarding the AC-130 gunship material and capability requirements described in chapter 4 of this thesis, the following recommendations are offered:

1. USSOCOM and AFSOC should investigate, select, fund, and support advanced technology development (ATD) and advanced concept technology demonstration (ACTD) activities related to the *JWSTP* and *DTAP* technology objectives described in chapter 4 of this thesis.

2. Based upon successful conclusion of the ATD and ACTD activities indicated above, USSOCOM and AFSOC should transition applicable advanced material

technologies into formal research, development, test, and evaluation (RDT&E) programs geared toward fielding advanced precision engagement capabilities on the AC-130 gunship.

3. AFSOC should further investigate the precision engagement-related technology goals and performance parameters contained in the *DTAP* and, where appropriate, develop Mission Need Statements (MNSs) and Operational Requirements Documents (ORDs) outlining the specific material requirements needed to conduct twenty-first century precision engagement operations.

4. USSOCOM and AFSOC should investigate the considerable body of on-going DOD research efforts which offer potential material solutions to the precision engagement requirements identified in chapter 4. The conventional military services are currently conducting a number of advanced technology RDT&E programs related to these requirements. Examples of these on-going programs include the advanced radar and electro-optic sensor systems being developed for unmanned aerial vehicles (UAVs), the Link-16 battlefield communications and coordination system, miniaturized global positioning system (GPS) guidance packages being developed for small-diameter precision munitions, the U.S. Army's XM915 Dual-Purpose Improved Conventional Munition (DPICM) for 105MM artillery systems, and U.S. Marine Corps initiatives in the area of nonlethal weapons technologies. Where appropriate, USSOCOM and AFSOC should co-invest in these advanced technology development programs with the conventional military services. Given USSOCOM's limited RDT&E and procurement budgets in comparison to those of the conventional military services, this strategy appears to offer the best hope for

incorporating advanced precision engagement systems and capabilities on the AC-130 gunship.

Suggested Topics for Further Research

Given the *JV 2010* implementation process is likely to continue for many years to come, a host of further research topics related to *JV 2010* and its new warfighting concepts present themselves. With regard to future requirements for Air Force Special Operations Forces, additional research should be conducted in order to refine the mission tasks and material needs described in *AFSOF 2025*. Given the three additional warfighting operational concepts identified in *JV 2010* (dominant maneuver, full-dimension protection, and focused logistics) and the wide variety of AFSOC weapon systems, AFSOC personnel should consider conducting additional research into the full realm of *JV 2010* operational concepts as they apply to all AFSOC weapon systems. Furthermore, to be fully successful in future military conflicts, AC-130 gunships will require advanced material systems and capabilities in addition to the precision engagement requirements indicated in chapter 4 of this thesis. These additional requirements include self-defense/electronic warfare systems, communications systems, aircraft propulsion systems, and battlefield situation awareness display systems. Finally, additional research could be conducted which further expands AC-130 employment doctrine, training, and simulation system requirements.

Summary

As indicated in chapter 1 of this thesis, the intent of this research effort was to establish a foundation for future AC-130 gunship modernization strategies. Chapter 4

contains a set of precision engagement-related mission requirements and tactical-level tasks derived from current JCS, service, and SOF vision publications which paint the picture of twenty-first warfare. Based upon these mission tasks and related DOD precision engagement technology objectives, chapter 4 identifies specific material systems and capabilities that AC-130 gunships will need in order to conduct precision engagement operations in the next century. Finally, this chapter offers specific recommendations for implementing these advanced material requirements on AC-130 gunships.

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